

# Cisco Catalyst 4500 Series Switches: Midsize Market Campus Design Considerations

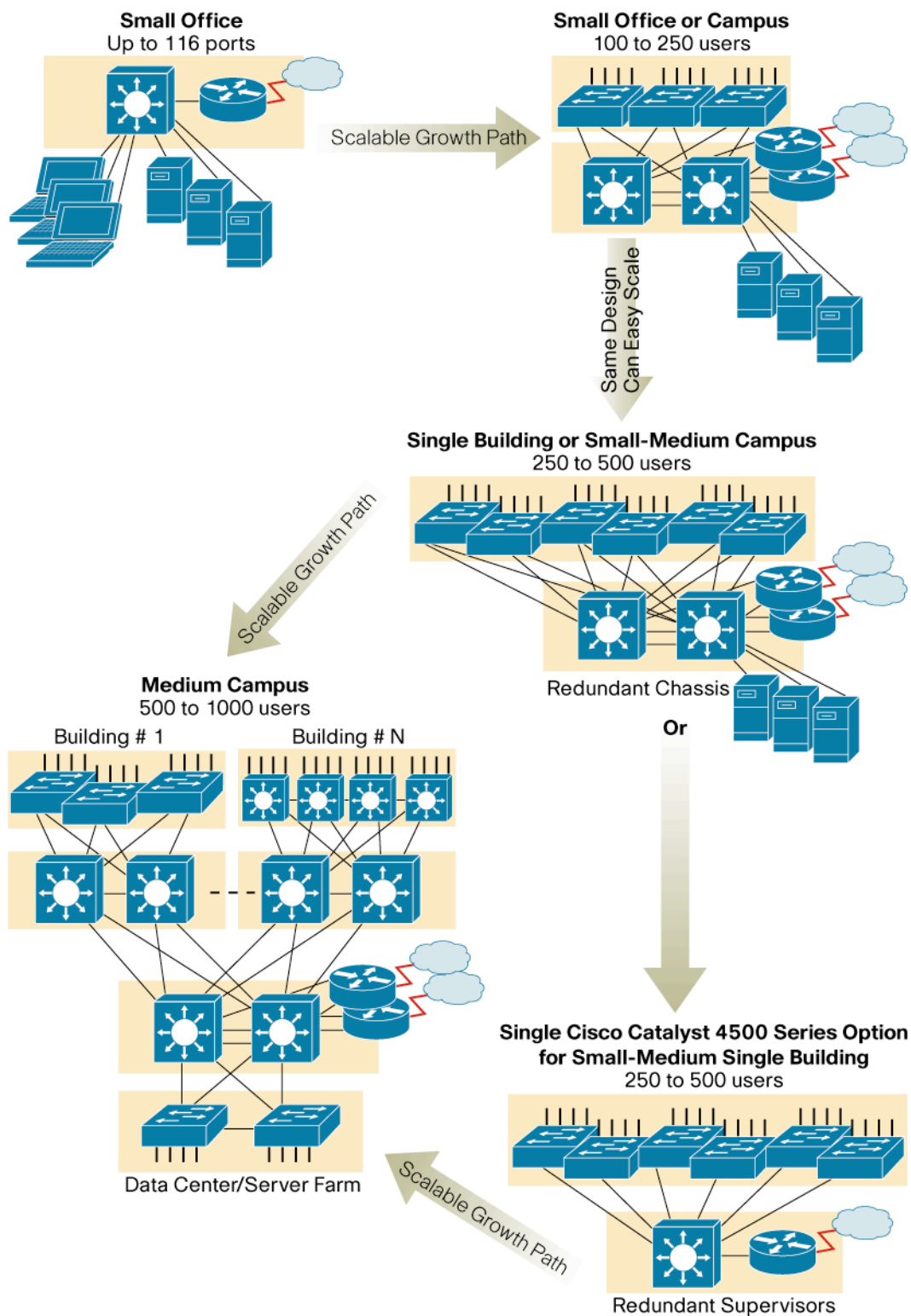
## Introduction

As businesses depend more and more on the network as a strategic business asset, they continually place higher demands on it. The Cisco® Catalyst® 4500 Series Switches are especially suited for strategic small and mid-sized businesses, which naturally scale through changing evolutionary stages such as foundational buildout, growth expansion, and optimization. This high-capability modular switch series delivers a flexible foundation solution on which an organization can be more competitive by effectively merging its IT plans with its business plans, all while helping ensure business resiliency with its high-availability features. The Cisco Catalyst 4500 Series also assures investment protection with its ability to securely fulfill multiple roles in the network such as access, distribution, and core.

This document provides design guidance and considerations for small and mid-sized networks with the Cisco Catalyst 4500 Series Switches. The same basic network design fundamentals such as security, high availability, manageability, scalability, and quality of service (QoS) apply whether the network is for an enterprise or a small or mid-sized business.

The primary purpose of this document is to illustrate how the Cisco Catalyst 4500 Series fulfills different functional network roles that provide a solid foundation solution for future business growth. A network designed with the Cisco Catalyst 4500 Series can transparently evolve as the business grows from 100 users to 1500 users. (See Figure 1.)

**Figure 1.** Growth and Evolution of Small Office or Campus Network with Cisco Catalyst 4500 Series Switches



## Midsize Market Campus Network Design Considerations

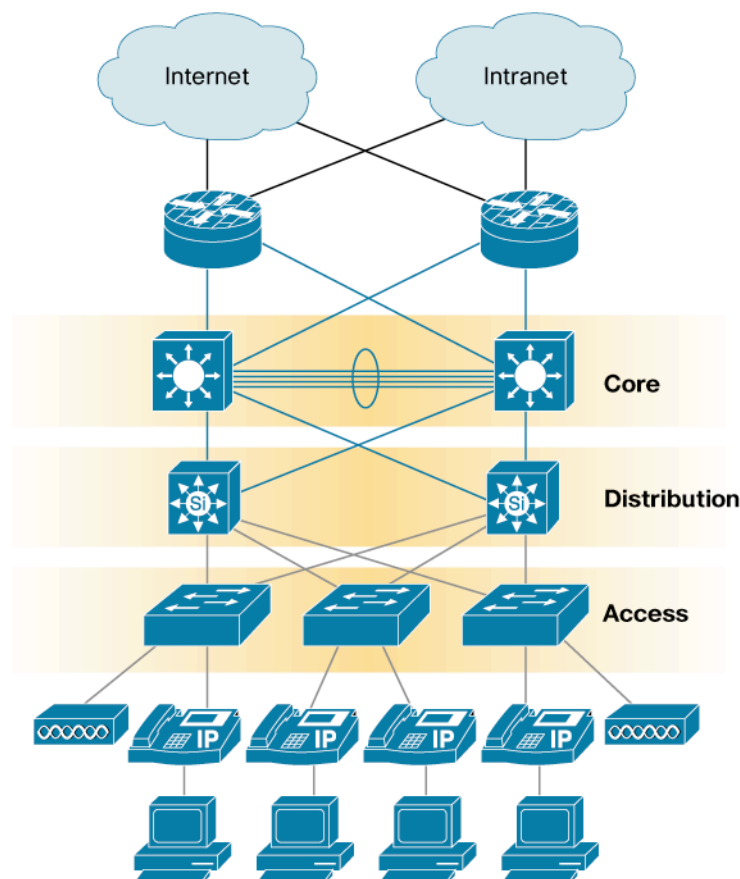
### Multitiered Networks

The standard Cisco network architecture is based on a multitiered model, which is broken into access, distribution, and core layers. To meet the needs of current and emerging technologies and networking needs, the campus network infrastructure is architected as a tiered model, which is easy to scale, understand, and troubleshoot. Networking functions such as Layer 2 switching, Layer 3 switching, security, high availability, quality of service, and so on are optimally distributed at each layer. The tiered network eliminates the need for a complex fully meshed network and scales transparently. In small and midsized network designs, the three tiers can also be implemented as a collapsed core and distribution design, or even a collapsed core distribution and access design.

The access layer provides entry into the network for end stations (PCs, phones, printers, and so on). Network access security is also applied in this layer. Typically, the access layer switch is dual-attached to the redundant distribution switches for high availability (HA). For efficient network resource and link utilizations both of the links are active, while the Layer 2 loop is avoided by layer 3 switching on the distribution layer.

The distribution layer provides aggregation for wiring closet switches and uplinks to the core. Access layer VLANs from the access switches are terminated on the distribution layer. A Layer 3 switched distribution layer allows the Layer 2 flooding domains to be kept smaller. The HSRP first hop redundancy is also implemented in the distribution layer switches. EtherChannel<sup>®</sup> protocols are also used for interconnecting the access switches with the distribution switches, for higher link availability and increased link capacity.

The core layer is responsible for high-speed data transfer and implemented as switched Layer 3 with IP routing protocol. In a multitiered network, the core will typically provide high-speed connectivity between two campuses, buildings, or floors (Figure 2).

**Figure 2.** Multitiered Network

### Layer 3 Campus Backbone

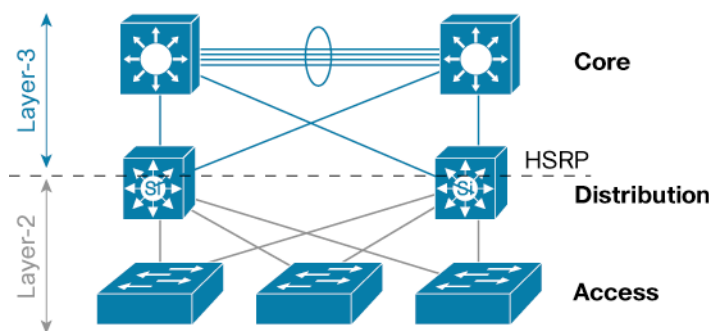
In a midsize campus, the backbone layer is typically a collapsed core and distribution. It is recommended to design a Layer 3 campus backbone and allow Layer 2 uplinks from the access layer to the collapsed core/distribution layer. The Layer 3 protocols such as HSRP, IGP, and load balancing can provide network wide resiliency and optimize the link utilization between access and distribution/core layers. The Layer 3 design also limits the flooding domain, eliminates spanning tree topologies in the campus network. A campus network design utilizes a balance between both Layer 2 and Layer 3 technology where necessary, and optimized with Layer 3 switching.

### Minimize Spanning Tree and Use Routing Protocols

The VLANs in the campus network are recommended to be terminated on the first Layer 3 device (typically on the distribution layer). The Layer 2 flooding domain and VLANs are kept smaller for predictable and manageable network performance. Spanning Tree and IP routing protocol help avoid broadcast loops and flooding in the campus network. Spanning tree designs are suboptimal from a link usage perspective as they block one of the links in the Layer 2 broadcast loop topology. (In spanning tree based designs, link optimization can be achieved through Per VLAN Spanning Tree [PVST] or Multiple Spanning Tree [MST] where both of the links are actively used for different VLANs.) Moreover, the dynamic nature of Spanning tree introduces operational complexity in the campus network. However, spanning tree is necessary to avoid Layer 2 loops in the network. A Layer 3 switched network reduces the potential Layer 2 loop in the network design. In addition, the Layer 3 switched design can optimize the network link utilization by efficient load balancing of the routed traffic. Routing protocols can be tuned to converge as fast as or faster than spanning-tree. For example, OSPF and EIGRP can be tuned to provide failover and optimal path selection within subseconds. Campus designs also use HSRP, where network convergence time can be optimized by tuning the HSRP timers.

Figure 3 demonstrates a recommended Layer 3 switched campus backbone with Layer 2 handoff to the wiring closet (access layer). The topology has no Layer 2 loops because of Layer 3 connection between the backbone layer switches. Every wiring closet is in a separate VLAN for data and voice. Each unique VLAN is mapped to a unique IP Subnet on the backbone layer switch. HSRP is configured between the backbone layer switches to provide default gateway redundancy.

**Figure 3.** Campus Backbone with Layer 3 Switching



The backbone layer serves as the Layer 3 core. Cisco recommends using Layer 3 connection between the two backbone layer switches instead of a VLAN trunk. All point-to-point links between switches are Gigabit Ethernet links.

### Server Farm Attached to Campus Backbone

A server farm consists of a logical group of networked servers that are usually housed in one location. These servers are sometimes placed into different groups based on their responsibility for handling various processes such as web, application, and database services. These server farms often take advantage of other infrastructure devices such as content switches to assist in offloading the processing requirements of individual servers and the server farm as a whole. Server farm Layer 2 access switches are typically connected to the Layer 3 campus backbone. However, the server farms may also be required to be connected to the same Layer 2 domain even though those are connected to separate access switches. For both Layer 2 and Layer 3 implementation, the server farms require high availability and the server farm access switches dual homed to the backbone network. The Layer 2 design requires spanning tree to avoid flooding loops. Spanning Tree Protocol as well as related features such as Root Guard, BackboneFast, UplinkFast, and LoopGuard needs should be considered for the network design and implementation. Further details on these protocols and configuration examples can be found at [http://www.cisco.com/en/US/partner/products/hw/switches/ps663/products\\_configuration\\_guide\\_chapter09186a00800dde9a.html](http://www.cisco.com/en/US/partner/products/hw/switches/ps663/products_configuration_guide_chapter09186a00800dde9a.html).

### Power over Ethernet (PoE)

Power over Ethernet (PoE) allows the IP phones, wireless access points, IP cameras, and so on to be powered through the Ethernet cables (UTP 5) from the Ethernet switches, which eliminates the need for separate power distribution for these network devices. The PoE standard (IEEE 802.3af) classifies the network devices based on the required power (in watts). The PoE capable network switches need to supply network devices with -48VDC power with sufficient power wattage over the Ethernet network. Table 1 lists the power requirements for various classes.

**Table 1.** Power Requirements

IEEE 802.3af Class	Required Power on the PoE Switch
0	15.4W-Default class
1	4W
2	7W
3	15.4W
4	Future expansion
Cisco pre-standard PoE	6.3W

For more information on PoE, please refer to

[http://www.cisco.com/en/US/partner/products/hw/switches/ps4324/products\\_white\\_paper09186a00801f44be.shtml](http://www.cisco.com/en/US/partner/products/hw/switches/ps4324/products_white_paper09186a00801f44be.shtml).

### Midsize Market Campus Network Deployment Scenarios

There are four common deployment scenarios based on the number of users in the network, which are:

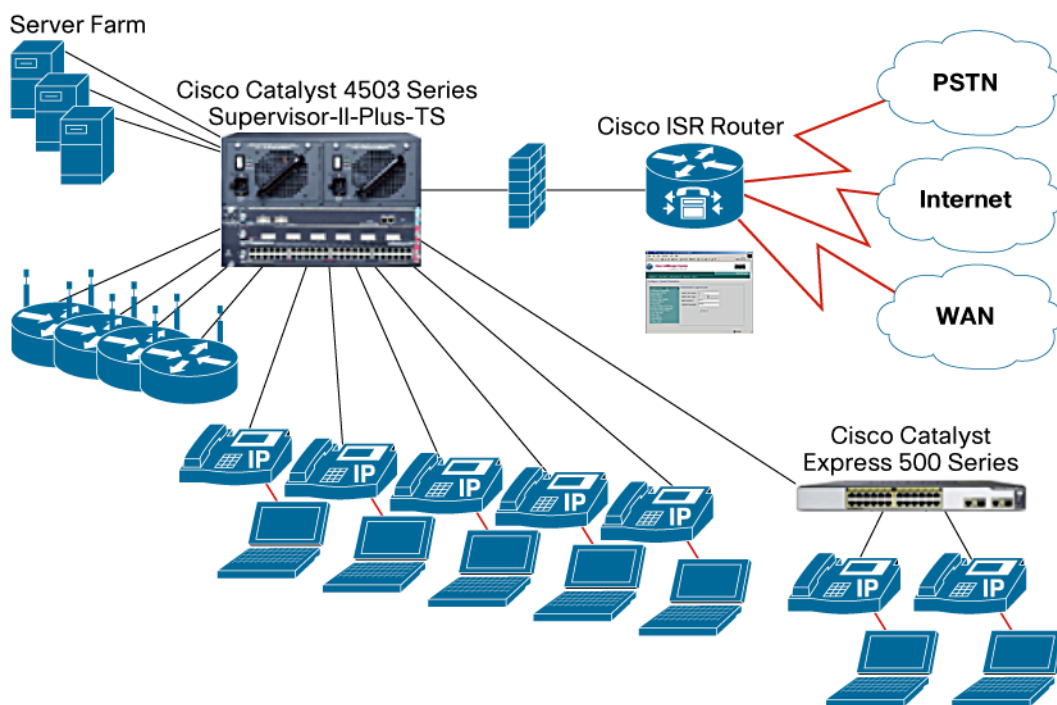
- **Small Office**—Up to 108 users
- **Small to Medium Campus**—Up to 250 users
- **Single Building Medium Campus**—Up to 500 users
- **Medium Campus**—Up to 1,500 users

**Note:** The listed features for each of the deployment scenarios are illustrated on the proceeding section (section 4) of this paper and on the reference documents that are listed in section 7.

### Small Office (up to 108 Users)

Small offices with up to 108 users can be served with a collapsed network design where three tiers of the campus design model are accommodated on a single Layer 3/Layer 3 switch. The foundation of the network backbone is built with the Cisco Catalyst 4503 Switch with Cisco Catalyst 4500 Series Supervisor Engine II-Plus-TS and basic Layer 3 software. The Cisco ISR provides the WAN connectivity, firewall and other services such as IP communications. (See Figure 4 and Table 2.)

**Figure 4.** Small Office (108 Users)



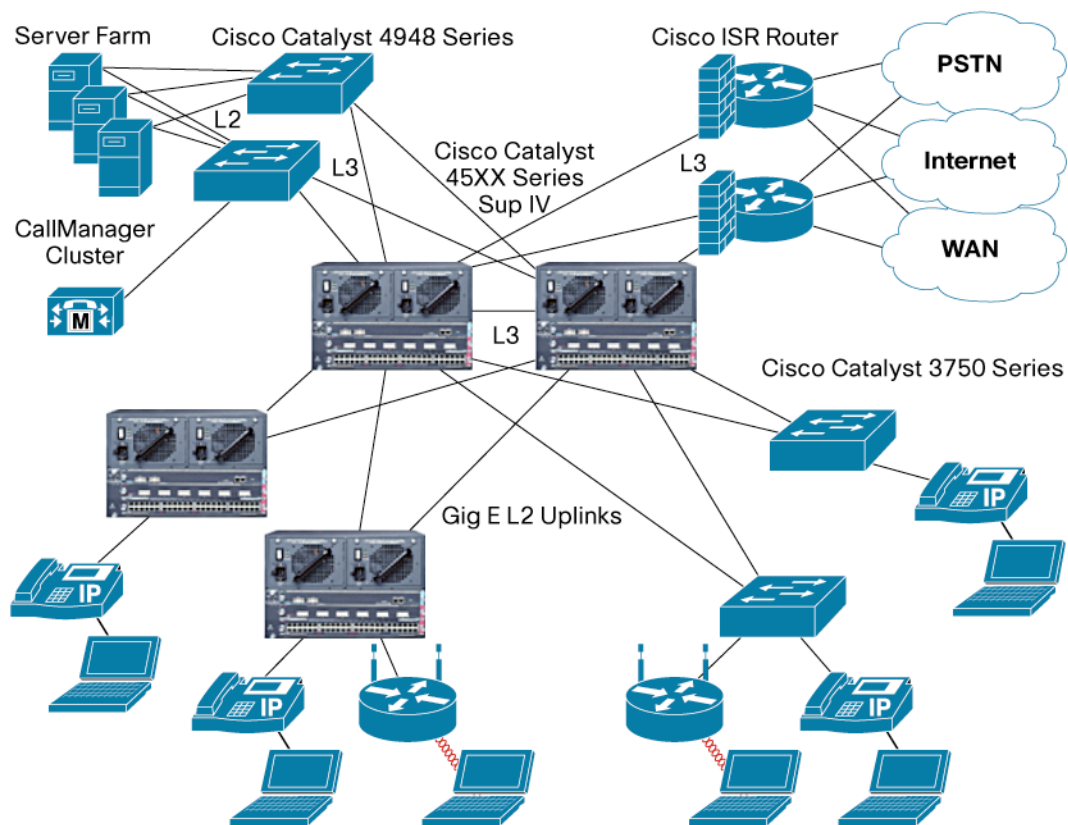
**Table 2.** Small Office (up to 108 Users)

Features	Description
<b>Network Design Overview</b>	The access, distribution and core layers are collapsed into one multilayer switch. A single Cisco Catalyst 4503 Switch equipped with Supervisor-II-Plus-TS serves as the access, distribution and core layer of the network. The Cisco Catalyst 4503 Switch can also be equipped with PoE line cards to support IP phones and wireless access points. Additional Ethernet access ports can be provided by adding access layer (Layer 2) switches in the design. The integrated services router (ISR) is used for WAN connectivity, firewall and call processing functions.
<b>Network Elements</b>	<p><b>Access, Distribution, and Core switches</b></p> <ul style="list-style-type: none"> <li>• Cisco Catalyst 4503 Switch with Supervisor-II-Plus-TS</li> </ul> <p><b>Additional Access Switches</b></p> <ul style="list-style-type: none"> <li>• Cisco Catalyst Express 500 Series Switches (for 10-20 additional Ethernet ports)</li> </ul> <p><b>Additional Network Elements</b></p> <ul style="list-style-type: none"> <li>• Cisco ISR (for WAN connectivity, firewall and call processing function)</li> <li>• Cisco wireless access points</li> <li>• Cisco IP phones</li> </ul>
<b>Major Feature Set</b>	<p><b>Scalability</b></p> <ul style="list-style-type: none"> <li>• 10/100/1000 (BaseT) port density—12 (on the Supervisor), 60 with one line card (L2 on the supervisor and 48 on the line card), 108 with two line cards (L2 on the supervisor and 48 on each line cards).</li> <li>• PoE port density—12 (on the supervisor), 60 with one line card (L2 on the supervisor and 48 on the line card), 108 with two line cards (12 on the supervisor and 48 on each line card). (With PoE power supply)</li> <li>• Uplink GigE (Optical) port density—8 on the supervisor (additional ports can be added using line cards)</li> <li>• Switching and forwarding capacity—64 Gbps and 48 million packets per second layer-2 through Layer 4 switching</li> </ul> <p><b>High Availability</b></p> <ul style="list-style-type: none"> <li>• Dual power supply (1+1 redundancy)</li> <li>• N+1 fan redundancy</li> <li>• Hot swappable line cards</li> <li>• High MTBF on the chassis and line cards</li> </ul> <p><b>Security</b></p> <ul style="list-style-type: none"> <li>• Access security (port security, ACL, IEEE 802.1x, DHCP Snooping, DAI, IP Source Guard)</li> <li>• Access Control Lists (Port ACL, VLAN ACL and Router ACL)</li> </ul> <p><b>Manageability and Ease of use</b></p> <ul style="list-style-type: none"> <li>• Cisco Network Assistant with SmartPorts</li> <li>• Auto QoS</li> </ul>

**Small to Medium Campus (up to 250 Users)**

Small to Medium campuses with 100 to 250 users can be served with a collapsed core and distribution network design. The collapsed core and distribution layer are built with the Cisco Catalyst 4500 Series Switches in a dual chassis network design. The dual chassis core and distribution layer are Layer 3 and the Layer 2 access switches are dual homed to distribution/core Cisco Catalyst 4500 Series Switches. The server farm Layer 3 switches are also dual homed to the core/distribution switches. The Cisco ISR provides the redundant WAN connectivity and firewall functions. (See Figure 5 and Table 3.)

**Figure 5.** Small to Medium Campus Dual Chassis Deployment (100 to 250 Users, Scalable to 500)



**Table 3.** Small to Medium size Campus (100 to 250 Users)

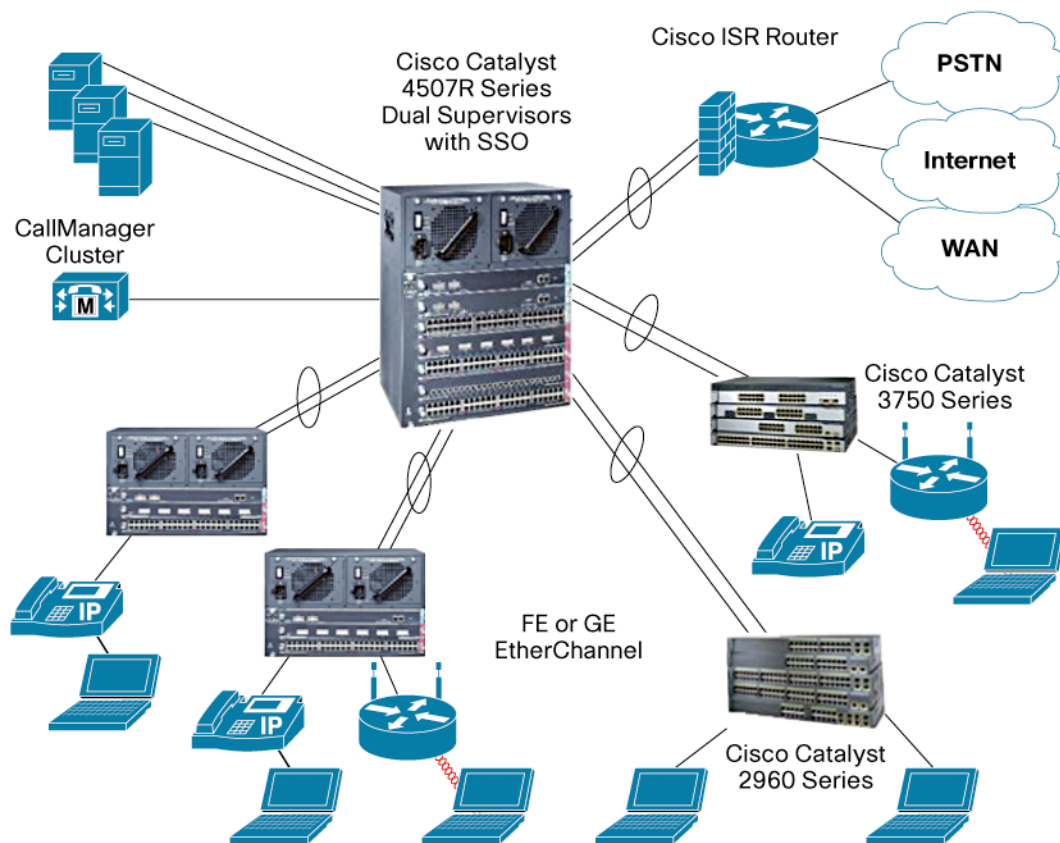
Features	Description
<b>Network Design Overview</b>	The distribution and core layers are collapsed into one multilayer switch with a dual chassis network design. The Cisco Catalyst S or 4506 Switches equipped with Supervisor-IV serve as the redundant core and distribution tier of the network. And Cisco Catalyst 4503 Switches equipped with Supervisor-II-Plus or Supervisor-II-Plus-TS are used as the Layer 2 access switch. The Cisco Catalyst 4503 Switches can be equipped with PoE line cards to support IP phones and wireless access points. The Integrated Services Router is used for WAN connectivity, and firewall functions.
<b>Network Elements</b>	<p><b>Distribution and Core Switches</b></p> <ul style="list-style-type: none"> <li>• Cisco Catalyst 4503 or 4506 Switch with Supervisor-IV</li> </ul> <p><b>Access Switches</b></p> <ul style="list-style-type: none"> <li>• Cisco Catalyst 4503 Switch with Supervisor-II-Plus-TS</li> <li>• Cisco Catalyst 3750 and 3550 Series Switches</li> </ul> <p><b>Server Farm Access Switches</b></p> <ul style="list-style-type: none"> <li>• Cisco Catalyst 4948 Switch</li> </ul> <p><b>Additional Network Elements</b></p> <ul style="list-style-type: none"> <li>• Cisco ISR (for WAN connectivity and firewall function)</li> <li>• Cisco IP phones</li> <li>• Cisco wireless access points</li> <li>• Cisco CallManager</li> </ul>

Features	Description
<b>Major Feature Set</b>	<p><b>Scalability</b></p> <ul style="list-style-type: none"> <li>• Access layer 10/100/1000 (BaseT) Port Density—12 (on the Supervisor), 60 with One Line card (12 on the Supervisor and 48 on the line card), 108 with two line cards (12 on the Supervisor and 48 on each line card) on each Cisco Catalyst 4503 Switch.</li> <li>• Access Layer PoE Port Density—12 (on the Supervisor), 60 with One Line card (12 on the Supervisor and 48 on the line card), 108 with two line cards (12 on the Supervisor and 48 on each line card) on each Cisco Catalyst 4503 Switch (With PoE Power Supply)</li> <li>• Access Layer Uplink GigE (Optical) Port density—Eight on the Supervisor (On each Cisco Catalyst 4503 Switch)</li> <li>• Access Layer Switching and forwarding Capacity—64 Gbps and 48 million Packets per second Layer 2 through Layer 4 switching (On each Cisco Catalyst 4503 Switch)</li> <li>• Distribution/Core 10/100/1000 (BaseT) Port Density—Up to 242 oversubscribed or 32 nonblocking (on Cisco Catalyst 4506 Switch), 98 oversubscribed or 26 nonblocking (on Cisco Catalyst 4503 Switch)</li> <li>• Distribution/Core Layer GigE (Optical) Port density—Two on the Supervisor, up to 96 oversubscribed or 14 nonblocking on Cisco Catalyst 4503 Switch, and up to 242 oversubscribed or 32 nonblocking on Cisco Catalyst 4506 Switch.</li> <li>• Distribution/Core Layer Switching and forwarding Capacity—64 Gbps and 48 million Packets per second Layer 2 through Layer 4 switching (On each Cisco Catalyst 4503 or 4506 Switch)</li> </ul> <p><b>High Availability</b></p> <ul style="list-style-type: none"> <li>• Dual Chassis Distribution/Core Design (With HSRP and IGP)</li> <li>• Dual homed Access Switches</li> <li>• Dual Power Supply (1+1 redundancy)</li> <li>• N+1 fan Redundancy</li> <li>• Hot Swappable Line cards</li> <li>• High MTBF on the Chassis and Line cards</li> </ul> <p><b>Security</b></p> <ul style="list-style-type: none"> <li>• Access Security (Port Security, ACL, IEEE 802.1x, DHCP Snooping, DAI, IP Source Guard) on Access Switches</li> <li>• Access Control Lists (PACL, VACL, RACL) on access and core/distribution switches</li> </ul> <p><b>Manageability and Ease of use</b></p> <ul style="list-style-type: none"> <li>• Cisco Network Assistant with SmartPorts</li> <li>• Auto QoS</li> </ul>

### Single Building Medium Campus (up to 500 Users)

Single building medium campus is categorized for campuses with 500 users typically served from a single building. The network is built with a collapsed core and distribution on a single Layer 2/Layer 3 switch. The collapsed core and distribution layer are built with the redundant Cisco Catalyst 4507R or 4510R Switch. The redundant chassis core/distribution layer is Layer 3, and the Layer 2 access switches are connected through EtherChannel to distribution/core Cisco Catalyst 4500 Series Switches. The Server farm Layer 3 switches are also connected through EtherChannel links to the core/distribution Switches. The Cisco ISR accommodates the redundant WAN connectivity and firewall functions. (See Figure 6 and Table 4.)

**Figure 6.** Medium Campus Single Chassis Deployment (200 to 500 Users)



**Table 4.** Medium Campus Single Chassis Deployment (200 to 500 Users)

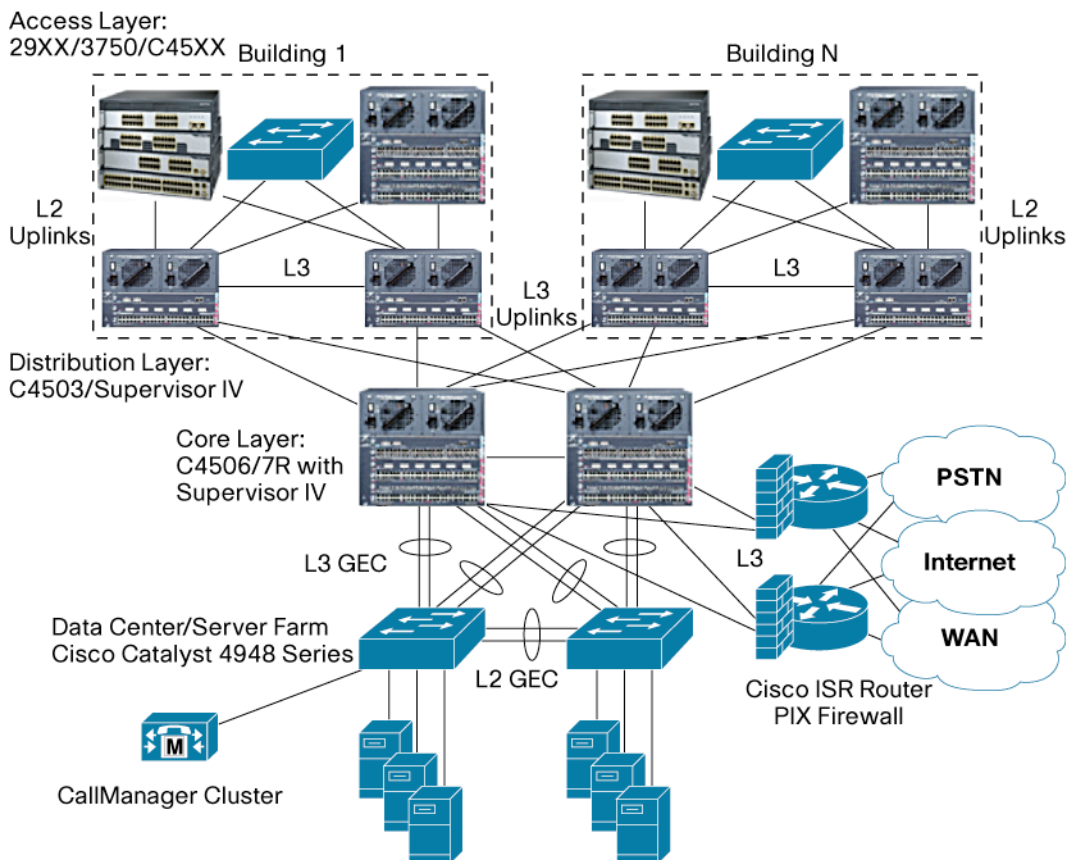
Features	Description
<b>Network Design Overview</b>	The Distribution and Core layers are collapsed into one multilayer Switch with Hardware redundancy. The Cisco Catalyst 4507R or 4510R Switches equipped with Supervisor-IV serve as the redundant core and distribution tier of the network. Cisco Catalyst 4503 Switches equipped with Supervisor-II-Plus or Supervisor-II-Plus-TS are used as the Layer 2 access switch. The Cisco Catalyst 4503 Switch can also be equipped with PoE line cards to support IP Phones and Wireless Access Points. The Integrated services Router is used for WAN connectivity, and firewall functions.
<b>Network Elements</b>	<p><b>Distribution and Core Switches</b></p> <ul style="list-style-type: none"> <li>Cisco Catalyst 4507R Supervisor-IV or Supervisor-V, or Cisco Catalyst 4510R with Supervisor-V</li> </ul> <p><b>Access Switches</b></p> <ul style="list-style-type: none"> <li>Cisco Catalyst 4503 Switch with Supervisor-II-Plus-TS</li> <li>Cisco Catalyst 3750</li> </ul> <p><b>Additional Network Elements</b></p> <ul style="list-style-type: none"> <li>Cisco ISR (for WAN connectivity and firewall function)</li> <li>Cisco IP Phones</li> <li>Cisco Wireless Access Points</li> <li>Cisco CallManager</li> </ul>

Features	Description
<b>Major Feature Set</b>	<p><b>Scalability</b></p> <ul style="list-style-type: none"> <li>• Access Layer 10/100/1000 (BaseT) Port Density—12 (on the Supervisor), 60 with One Line card (12 on the Supervisor and 48 on the line card), 108 with two line cards (12 on the Supervisor and 48 on each line cards) on each Cisco Catalyst 4503 Switch.</li> <li>• Access Layer PoE Port Density—12 (on the Supervisor), 60 with One Line card (12 on the Supervisor and 48 on the line card), 108 with two line cards (12 on the Supervisor and 48 on each line card) on each Cisco Catalyst 4503 Switch. (With PoE Power Supply)</li> <li>• Access Layer Uplink GigE (Optical) Port density—Eight on the Supervisor (On each Cisco Catalyst 4503 Switch)</li> <li>• Access Layer Switching and forwarding Capacity—64 Gbps and 48 million Packets per second Layer 2 through Layer 4 switching (On each Cisco Catalyst 4503 Switch)</li> <li>• Distribution/Core 10/100/1000 (BaseT) Port Density—Up to 242 oversubscribed or 32 nonblocking (on Cisco Catalyst 4507R Switch), 386 oversubscribed or 50 nonblocking (on Cisco Catalyst 4510R Switch)</li> <li>• Distribution/Core Layer GigE (Optical) Port density—Two on the Supervisor, up to 242 oversubscribed or 32 nonblocking on Cisco Catalyst 4507R Switch, and up to 386 oversubscribed or 50 nonblocking on Cisco Catalyst 4510R Switch.</li> <li>• Distribution/Core Layer Switching and forwarding Capacity—64 Gbps and 48 million Packets per second Layer 2 through Layer 4 switching (with Supervisor-IV), 96 Gbps and 72 million Packets per second Layer 2 through Layer 4 switching (with Supervisor-V)</li> </ul> <p><b>High Availability</b></p> <ul style="list-style-type: none"> <li>• Redundant Supervisor on the Distribution/Core Switches with SSO</li> <li>• EtherChannel between Access Switches and Distribution/Core Switch</li> <li>• Dual Power Supply (1+1 redundancy)</li> <li>• N+1 fan Redundancy</li> <li>• Hot Swappable Line cards</li> <li>• High MTBF on the Chassis and Line cards</li> </ul> <p><b>Security</b></p> <ul style="list-style-type: none"> <li>• Access Security (Port Security, ACL, IEEE 802.1x, DHCP Snooping, DAI, IP Source Guard) on the access switches</li> <li>• Access Control Lists (PACL, VACL, RACL) on access and core/distribution switches</li> <li>• Private VLAN (PVLAN) for Server Farms</li> </ul> <p><b>Manageability and Ease of use</b></p> <ul style="list-style-type: none"> <li>• Cisco Network Assistant with SmartPorts</li> <li>• Auto QoS</li> </ul>

### Medium Campus (up to 1,500 Users)

A medium size campus with up to 1,000 users is designed with multitier network architecture. The Layer 3 core and distribution, and Layer 2 Access layers are built with Cisco Catalyst 4500 Series Switches. The network resiliency is obtained through dual chassis architecture in Core and distribution layers. The Layer 2 access switches are dual homed to the distribution Cisco Catalyst 4500 Series Switches. The Server farm Layer 3 switches are also dual homed to the distribution Switches. The Cisco ISR accommodates the redundant WAN connectivity and firewall functions. (See Figure 7 and Table 5.)

**Figure 7.** Medium Campus Design with Multitier Deployment (500 to 1,500 Users)



**Table 5.** Medium Campus (500 to 1000 Users)

Features	Description
<b>Network Design Overview</b>	The network design consists of three tiers; Access, distribution and Core where the distribution and core is Layer 3 where the access is Layer 2. The Cisco Catalyst 4500 Series Switches are used for Access, Aggregation and Core layer designs. The Cisco Catalyst 4503 Switch is used as Layer 2 access switch equipped with Power supply module and PoE line cards to support IP Phones and Wireless Access Points. The Integrated services Router is used for WAN connectivity, and firewall functions.
<b>Network Elements</b>	<p><b>Core Switches</b></p> <ul style="list-style-type: none"> <li>• Cisco Catalyst 4506 or 4507R Switch with Supervisor-IV</li> </ul> <p><b>Distribution Switches</b></p> <ul style="list-style-type: none"> <li>• Cisco Catalyst 4503 Switch with Supervisor-IV</li> </ul> <p><b>Access Switches</b></p> <ul style="list-style-type: none"> <li>• Cisco Catalyst 4503 Switch with Supervisor-II-Plus-TS</li> <li>• Cisco Catalyst 4506 with Supervisor-II-Plus</li> <li>• Cisco Catalyst 3750 and 3550 Series</li> </ul> <p><b>Server Farm Access Switches</b></p> <ul style="list-style-type: none"> <li>• Cisco Catalyst 4948</li> </ul> <p><b>Additional Network Elements</b></p> <ul style="list-style-type: none"> <li>• Cisco ISR (for WAN connectivity and firewall function)</li> <li>• Cisco IP Phones</li> <li>• Cisco Wireless Access Points</li> <li>• Cisco CallManager</li> </ul>

Features	Description
<b>Major Feature Set</b>	<p><b>Scalability</b></p> <ul style="list-style-type: none"> <li>• Access Layer 10/100/1000 (BaseT) Port Density—12 (on the Supervisor), 60 with One Line card (12 on the Supervisor and 48 on the line card), 108 with two line cards (12 on the Supervisor and 48 on each line cards) on each Cisco Catalyst 4503 Switch.</li> <li>• Access Layer PoE Port Density—12 (on the Supervisor), 60 with One Line card (12 on the Supervisor and 48 on the line card), 108 with two line cards (12 on the Supervisor and 48 on each line cards) on each Cisco Catalyst 4503 Switch. (With PoE Power Supply)</li> <li>• Access Layer Uplink GigE (Optical) Port density—Eight on the Supervisor (On each Cisco Catalyst 4503 Switch)</li> <li>• Access Layer Switching and forwarding Capacity—64 Gbps and 48 million Packets per second Layer 2 through Layer 4 switching (On each Cisco Catalyst 4503 Switch)</li> <li>• Distribution/Core 10/100/1000 (BaseT) Port Density—Up to 242 oversubscribed or 32 nonblocking (on Cisco Catalyst 4506 Switch), 98 oversubscribed or 14 nonblocking (on Cisco Catalyst 4503 Switch)</li> <li>• Distribution/Core Layer GigE (Optical) Port density—Two on the Supervisor, up to 98 oversubscribed or 14 nonblocking on Cisco Catalyst 4503 Switch, and up to 242 oversubscribed or 32 nonblocking on Cisco Catalyst 4506 Switch/Cisco Catalyst 4507R Switch</li> <li>• Distribution/Core Layer Switching and forwarding Capacity—64 Gbps and 48 million Packets per second Layer 2 through Layer 4 switching (On Supervisor-IV)</li> </ul> <p><b>High Availability</b></p> <ul style="list-style-type: none"> <li>• Dual Chassis Distribution/Core Design with HSRP</li> <li>• Optional Redundant Supervisor with SSO on the Core</li> <li>• Dual homed Access Switches</li> <li>• Dual Power Supply (1+1 redundancy)</li> <li>• N+1 fan Redundancy</li> <li>• Hot Swappable Line cards</li> <li>• High MTBF on the Chassis and Line cards</li> </ul> <p><b>Security</b></p> <ul style="list-style-type: none"> <li>• Access Security (Port Security, ACL, IEEE 802.1x, DHCP Snooping, DAI, IP Source Guard) on access switches</li> <li>• Access Control Lists (PACL, VACL, RACL)</li> <li>• Private VLAN (PVLAN) on the Server Farm access switch</li> </ul> <p><b>Manageability and Ease of use</b></p> <ul style="list-style-type: none"> <li>• CiscoWorks</li> <li>• Auto QoS</li> </ul>

## Campus Network Design Considerations with Cisco Catalyst 4500 Series Switch

### Business Resiliency

As businesses increase deployment of mission critical applications over a unified IP network, network resiliency becomes critical to business success. No longer can customers endure unplanned or planned network outages without negatively impacting their business. Network uptime is guaranteed through the hardware availability, software availability and the high-availability network design.

Supervisor-engine redundancy—the Cisco Catalyst 4507R and 4510R Switches support 1+1 supervisor-engine redundancy for integrated resiliency. Redundant supervisor engines help minimize network downtime, facilitating business continuance and increasing employee productivity. Nonstop Forwarding with Stateful Switchover (NSF/SSO) offers continuous packet forwarding during supervisor engine switchover. Information is fully synchronized between supervisors to allow the standby supervisor to immediately take over in subsecond time if the primary fails. NSF/SSO dramatically improves the network reliability and availability in a Layer 2 or Layer 3 environment. NSF/SSO is essential for business-critical applications such as voice over IP (VoIP). As a result, VoIP calls are not dropped.

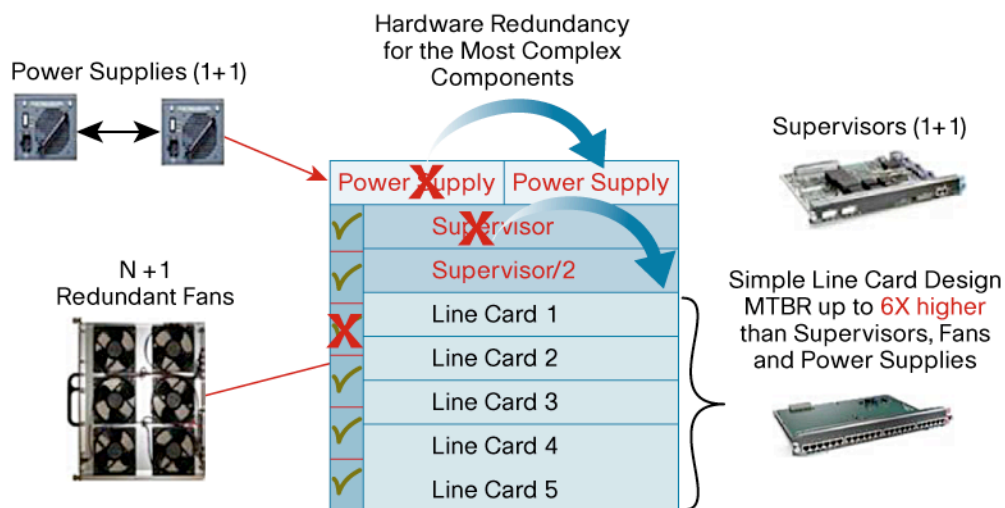
Additionally, the Cisco Catalyst 4500 Series provides an industry first, In Service Software Upgrade (ISSU). ISSU allows customers to upgrade or downgrade the complete Cisco Catalyst 4500 Series Cisco IOS Software image without having to take the switch or network out of service. With ISSU, the Cisco Catalyst 4500 Series is redefining total system availability. Combined with existing innovative high-availability features, the Cisco Catalyst 4500 Series delivers a “nonstop” Ethernet switching platform capable of system availability beyond five nines.

Hardware availability is increased by a redundant hardware design, which includes redundancy for power supply, switching fabric and processor. The Cisco Catalyst 4500 Series Switches also offer hot standby (1+1 redundancy) power supply which operates in load sharing mode, and fan (N+1 redundancy) redundancy on all the chassis form factor (Cisco Catalyst 4503, 4506, 4507R, and 4510R Switches). For robust high-availability requirements in the core/distribution layer, the Cisco Catalyst 4500 Series also offers switch fabric and processor (Supervisor) redundancy on the Cisco Catalyst 4507R Switch and 4510R chassis. The Cisco Catalyst 4500 Series Switches also support hot swappable line cards including the redundant Supervisor, which eliminates the need for any system reset or reload during capacity upgrades by adding new line cards or replacement of any line cards.

The hardware high-availability features are augmented with the software high availability to obtain system level high availability of the Cisco Catalyst 4500 Series Switches. Software availability includes Cisco IOS Software Stateful Switchover (SSO) which allows sub second switchover from working Supervisor to the redundant Supervisor in Cisco Catalyst 4507R and 4510R chassis equipped with dual Supervisor against any hardware or software failure encountered on the active Supervisor.

The network level availability and redundancy is obtained through the network and interconnect protocols such as Cisco EtherChannel technology; Multigroup Hot Standby Router Protocol (MHSRP); Per-VLAN Spanning Tree; Uplink and Backbone Fast; Root Guard/BPDU Guard; PortFast; Cisco Express Forwarding load balancing; and Open Shortest Path First (OSPF) Fast Convergence. (See Figure 8.)

**Figure 8.** Cisco Catalyst 4507R Hardware Redundancy (1+1 Power supply, N+1 Fan, Redundant Supervisor)



The Cisco Catalyst 4507R chassis equipped with Supervisor Engines II-Plus, II-Plus-10GE, IV, V, and V-10GE and 4510R chassis equipped with Supervisor Engines V, and V-10GE support Supervisor redundancy. The Cisco Catalyst 4507R and 4510R equipped with dual supervisors (with Cisco IOS Software release of 12.2(20)EWA or later) support sub-second failover through Cisco IOS Software SSO technology which eliminates any link reset, MAC relearning, and spanning tree reconvergence during the switchover. As a result, a Supervisor switchover does not affect the ongoing traffic or drop any active IP phone calls. Layer 3 convergence is also dramatically reduced by SSO through maintaining the link states up throughout the supervisor switchover.

For more information regarding the Cisco Catalyst 4500 Series High-Availability features, please refer to

[http://www.cisco.com/application/pdf/en/us/guest/products/ps4324/c1031/cdccont\\_0900aecd802a492c.pdf](http://www.cisco.com/application/pdf/en/us/guest/products/ps4324/c1031/cdccont_0900aecd802a492c.pdf).

### Security

Network security and Denial-of-service (DoS) attacks continue to be a serious challenge in campus and enterprise networks. Proactive network security model is needed which should be designed to prevent attacks by keeping the outsiders out and the insiders honest in the campus networks. The Cisco Catalyst 4500 Series supports a robust set of security features and technology for SBM campus network security ranging from wiring closet up to the enterprise core. The network access layer security technology includes Port Security, Access Control List (ACL), IEEE 802.1x authentication, DHCP Snooping and Option-82, Dynamic ARP Inspection (DAI), IP Source Guard, and Private VLAN (PVLAN). These security features and technologies can be used in conjunction to protect the network from Denial of Service and Man in the Middle attacks. Table 6 gives brief functional descriptions of these features.

**Table 6.** Feature Descriptions

Security feature	Functional Description
<b>Port Security</b>	Restrict input to an interface by limiting and identifying MAC addresses of the workstations that are allowed to access the port.
<b>ACL</b>	ACLs allow a user to specify Access lists to filter traffic on a per Port, VLAN or IP Routed interface basis.
<b>IEEE 802.1x</b>	IEEE 802.1x is a client-server-based access control and authentication protocol that restricts unauthorized devices from connecting to a LAN.
<b>DHCP Snooping and Option-82</b>	DHCP snooping is a DHCP security feature that provides security by filtering un-trusted DHCP messages and by building and maintaining a DHCP snooping binding table. An un-trusted message is a message that is received from outside the network or firewall and that can cause traffic attacks within the network. The Option-82 allows the access switches to add the origination port ID of the switch on the DHCP request to the DHCP server.
<b>DAI</b>	Dynamic ARP inspection (DAI) uses the binding information that is built by DHCP snooping to enforce the advertisement of bindings to prevent "man-in-the-middle" attacks. These attacks can occur when an attacker intercepts and selectively modifies communicated data to masquerade as one or more of the entries in a communication association. DAI adds an extra layer of security to ARP inspection by verifying that the ARP packet's MAC address and IP address match an existing DHCP snooping binding in the same VLAN.
<b>IP Source Guard</b>	IP source guard provides per port IP traffic filtering of the assigned source IP addresses by binding IP address to ports.
<b>PVLAN</b>	Allows multiple VLANs with Layer 2 isolation to exist within a single subnet. Provides security by preventing access to an entire network through a single server; also can save address space.

For more details about Cisco Catalyst 4500 Series security, please refer to

[http://www.cisco.com/application/pdf/en/us/guest/products/ps4324/c1031/cdccont\\_0900aecd802be05b.pdf](http://www.cisco.com/application/pdf/en/us/guest/products/ps4324/c1031/cdccont_0900aecd802be05b.pdf).



### **Scalability**

The Cisco Catalyst 4500 Series Switch architecture is optimized for scalable campus network designs with the modular chassis design, which allows network growth by adding new line cards on the chassis. The Cisco Catalyst 4500 Series Switches can support from 64 Gbps to 136 Gbps switching capacity and from 96 to 384 Ethernet ports in a single Chassis. The Cisco proprietary ASIC based Supervisor cards can support up to 32,000 to 55,000 Unicast MAC entries and 16,000 Multicast MAC entries simultaneously. The ACL, QoS and Security implementation in Hardware also allows line rate switching and forwarding performance.

The modular design of the Cisco Catalyst 4500 Series allows ease of migration as the size of the network increases with business growth. Line cards are added as port density requirements grow; new line cards are appended such as Power over Ethernet (PoE) to support new client devices in the network such as IP Phones, wireless Access Points or IP Cameras. Supervisor cards are interchanged to enable further switching robustness or new features and software capabilities such as advanced routing protocols or Netflow. The Power supply modules are also interchanged to support increased density of PoE ports on the Switch.

### **Cost Effectiveness**

The Cisco Catalyst 4500 Series centralized architecture allows for a cost effective solution for future growth and expansion. It is possible to upgrade the performance and feature support of the switch by simply upgrading the Supervisor Engines while reusing all the existing line cards. This unique architecture to the Cisco Catalyst 4500 Series is a key feature for future expansion and growth allowing customer to deploy the network with the supervisors that suffice the current network needs, and as the network requirements grow, the Supervisor card can be upgraded to more robust one instead of a forklift upgrade of the whole chassis.

Since each Cisco Catalyst 4500 Series chassis can accommodate different types of line cards simultaneously, a single chassis in Access or Aggregation/core layer of the network can support various types of network connectivity such as 10BaseT, 100BaseT, 1000BaseT, 1000BaseX, and PoE. The Supervisor and Line cards are also shared across the various form factors of the Cisco Catalyst 4500 Series Switches.

### **High Feature Capacity**

Scalability of these intelligent network services is made possible with dedicated specialized resources known as ternary content addressable memory (TCAM). Ample TCAM resources (up to 192,000 entries) enable “high feature capacity,” which provides wire-speed routing/switching performance with concurrent provisioning of services such as QoS and security. This helps ensure scalability for today’s network requirements with ample room for future growth.

## Conclusion

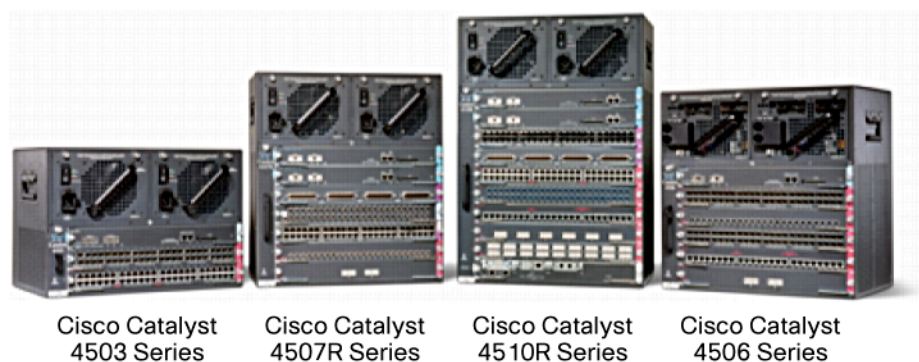
The Cisco Catalyst 4500 Series is a high-capability switch equipped with many features to fit virtually any Campus and Small Medium Business (SMB) network deployment scenario. The Cisco Catalyst 4500 Series is a high-performance switch that meets the networking needs of a Small Medium Business with features such as Security, High Availability, Manageability, Scalability, and QoS. The Cisco Catalyst 4500 Series features a centralized modular architecture that provides operational simplicity, media flexibility, and expandability, which extends deployment life while reducing the cost of ownership by minimizing recurring operational expenses and improving return on investment (ROI). The Cisco Catalyst 4500 Series delivers:

- **Integrated network security**—Comprehensive features and technologies provide peace of mind against ever increasing threats such as theft of information or worms and viruses.
- **Investment protection**—An evolutionary centralized architecture allows for the easy upgrade of all system ports to higher level functions with simple supervisor upgrades
- **Business Resiliency**—Hardware and software based high-availability features are designed into the architecture to prevent network outages.
- **Ease of use and manageability**—Web-based management offers centralized control of configuration and management of all ports for operational simplicity.
- **Power over Ethernet (PoE)**—Enables the deployment of new applications such as IP telephony, Wi-Fi access, video surveillance, building management systems, and remote video kiosks. The Cisco Catalyst 4500 Series is uniquely suited for PoE scalability.
- **Scalability**—This high-density solution offers up to 102Mpps nonblocking performance independent of the number of security policies or layer 3 services enabled
- **Deployment flexibility**—Cisco Catalyst 4500 Series offers a broad selection of chassis, high-performance supervisors, line cards, and power supplies

## Appendix—Cisco Catalyst 4500 Series

Cisco Catalyst 4500 Series Switches integrate nonblocking layer 2-4 switching with optimal control, helping enable business resilience for enterprises, small and medium-sized businesses (SMBs), and Metro Ethernet customers deploying business-critical applications. The Cisco Catalyst 4500 Series extends control to the network edge with intelligent network services, including sophisticated quality of service (QoS), predictable performance, advanced security, and comprehensive management. It delivers advanced control with integrated resiliency. Integrated resiliency in both hardware and software minimizes network downtime, helping to ensure workforce productivity, profitability, and customer success. The modular architecture, media flexibility, and expandability of the Cisco Catalyst 4500 Series extends deployment life while reducing the cost of ownership by minimizing recurring operational expenses and improving return on investment (ROI). (See Figure 10.)

**Figure 10.** Cisco Catalyst 4500 Series Switches



For further details on the Cisco Catalyst 4500 Series Switches, refer to <http://www.cisco.com/en/US/products/hw/switches/ps4324/index.html>.

Table 7 shows Cisco Catalyst 4500 Series chassis types.

**Table 7.** Cisco Catalyst 4500 Series Chassis Types

Model	Cisco Catalyst 4510R Switch	Cisco Catalyst 4507R Switch	Cisco Catalyst 4506 Switch	Cisco Catalyst 4503 Switch
Total Slots	10	7	6	3
Supervisor Engine Slots	2	2	1 <sup>1</sup>	1 <sup>1</sup>
Supervisor Engine Redundancy	Yes (Supervisor Engine V and V-10GE)	Yes (Supervisor Engine II-Plus, IV, V, V-10GE)	No	No
Supervisor Engines Supported	Supervisor Engine V and V-10GE	Supervisor Engine II-Plus, IV, V, V-10GE	Supervisor Engine II-Plus, IV, V, V-10GE	Supervisor Engine II-Plus, II-Plus-TS, IV, V, V-10GE
Line Card Slots	8	5	5	2
10/100/1000Base-T Port Density	384	240	240	108
PoE Port Density	384	240	240	108

Table 8 shows Cisco Catalyst 4500 Series supervisors.

<sup>1</sup> Slot 1 is reserved for supervisor engine only; slots 2 and higher are reserved for line cards.

**Note:** Supervisor engine slots do not support switching line card modules. Line card slots do not support supervisor engines.

**Table 8.** Cisco Catalyst 4500 Series Supervisors

Supervisor Engines	Layer 2/3/4 Services	Bandwidth/ Throughput	Chassis Support	Uplinks	Number of Routes	Security / QoS Entries	Input/ Output Policers	NAC/DHCP Snoop Entries
<b>Supervisor V-10GE</b>	Full Layer 2/3/4 EIGRP/OSPF/ BGP/IS-IS	136 Gbps/ 102Mpps	Cisco Catalyst 4503, 4506, 4507R, 4510R	4GE and 2 10GbE	128K routes	64K	8000/ 8000	6000/6000
<b>Supervisor V</b>	Full Layer 2/3/4 EIGRP/OSPF/ BGP/IS-IS	96 Gbps/ 72Mpps	Cisco Catalyst 4503, 4506, 4507R, 4510R	2GE	128K routes	64K	1000/ 1000	3000/3000
<b>Supervisor IV</b>	Full Layer 2/3/4 EIGRP/OSPF/ BGP/IS-IS	64 Gbps/ 48Mpps	Cisco Catalyst 4503, 4506, 4507R	2GE	128K routes	64K	1000/ 1000	3000/3000
<b>Supervisor II-Plus-10GE</b>	Basic Layer 2/3/4	108 Gbps/ 81Mpps	Cisco Catalyst 4503, 4506, 4507R	4GE and 2 10GbE	32K routes	32K	512/512	3000/3000
<b>Supervisor II-Plus</b>	Basic Layer 2/3/4	64 Gbps/ 48Mpps	Cisco Catalyst 4503, 4506, 4507R	2GE	32K routes	32K	512/512	3000/3000
<b>Supervisor II-Plus-TS</b>	Basic Layer 2/3/4	64 Gbps/ 48Mpps	Cisco Catalyst 4503 only	8GE and 12 10/100/1000 PoE	32K routes	32K	512/512	3000/3000

For more information on the Cisco Catalyst 4500 Series supervisors please refer to the following link

[http://www.cisco.com/en/US/products/hw/switches/ps4324/products\\_data\\_sheet0900aecd803fae7d.html#table3](http://www.cisco.com/en/US/products/hw/switches/ps4324/products_data_sheet0900aecd803fae7d.html#table3).

### Cisco Catalyst 4500 Series Software Features

The Cisco Catalyst 4500 Series Switch architecture operates with a single Cisco IOS Software image for Supervisor Engines II-Plus-TS, II-Plus, II-Plus-10GE, IV, V, and V-10GE. The major software feature sets are shown in Table 9.

**Table 9.** Software Features

Features	Description
<b>Layer 2</b>	802.1Q and Layer 2 Protocol Tunneling, Cisco Discovery Protocol (CDP), EtherChannel Bundles, Jumbo Frames, Baby Giants, Multiple Spanning Tree (MST), Per-VLAN Rapid Spanning Tree (PVRST+), QoS, Spanning Tree Protocol (STP), Stateful Switchover (SSO), Unidirectional Ethernet, and 4,096 VLANs.
<b>Layer 3</b>	Cisco Express Forwarding, Hot Standby Router Protocol (HSRP), RIP, OSPF, EIGRP, BGP, IP Multicast services, Policy-based Routing, Unidirectional Link Routing, and VRF-lite.
<b>Security</b>	DHCP snooping, Dynamic ARP Inspection (DAI), IP source guard, Port Security, 802.1x and enhancements, Layer 2-4 access control lists (ACLs) including port-based access control list (PACL), and Private VLANs including private VLAN isolated trunk.
<b>Management</b>	Cisco Network Assistant and embedded CiscoView, Dynamic Host Control Protocol (DHCP), Forced 10/100 auto-negotiation, intelligent power management, Netflow statistics, Secure shell (SSH), SNMP, Switched Port Analyzer (SPAN), and Remote SPAN (RSPAN).

For more documentation and detail on the Cisco Catalyst 4500 Series Software features please refer to <http://www.cisco.com/kobayashi/sw-center/lan/cat4000.shtml>.

The Cisco Catalyst 4948 and 4948-10GE are also full line rate switches designed for high-bandwidth applications such as server farms and data centers. For more information regarding the Cisco Catalyst 4900 Series Switch family, please refer to [http://www.cisco.com/en/US/products/ps6021/products\\_data\\_sheet0900aecd80246552.html](http://www.cisco.com/en/US/products/ps6021/products_data_sheet0900aecd80246552.html).

## References

- **Cisco Catalyst 4503 Supervisor II-Plus-TS Data Sheet—**  
[http://www.cisco.com/en/US/products/hw/switches/ps4324/products\\_data\\_sheet0900aecd8017a0c5.html](http://www.cisco.com/en/US/products/hw/switches/ps4324/products_data_sheet0900aecd8017a0c5.html)
- **Cisco Catalyst 4500 Supervisor IV Data Sheet—**  
[http://www.cisco.com/en/US/products/hw/switches/ps4324/products\\_data\\_sheet0900aecd8035cf2b.html](http://www.cisco.com/en/US/products/hw/switches/ps4324/products_data_sheet0900aecd8035cf2b.html)
- **Cisco Catalyst 4500 Supervisor II-Plus Data Sheet—**  
[http://www.cisco.com/en/US/products/hw/switches/ps4324/products\\_data\\_sheet09186a0080197424.html](http://www.cisco.com/en/US/products/hw/switches/ps4324/products_data_sheet09186a0080197424.html)
- **Cisco Catalyst 4500 Supervisor V Data Sheet—**  
[http://www.cisco.com/en/US/products/hw/switches/ps4324/products\\_data\\_sheet09186a00801fcaba.html](http://www.cisco.com/en/US/products/hw/switches/ps4324/products_data_sheet09186a00801fcaba.html)
- **Line Card Data Sheet—**  
[http://www.cisco.com/en/US/products/hw/switches/ps4324/products\\_data\\_sheet0900aecd802109ea.html](http://www.cisco.com/en/US/products/hw/switches/ps4324/products_data_sheet0900aecd802109ea.html)
- **Cisco Network Assistant Data Sheet—**<http://www.cisco.com/go/NetworkAssistant>
- **Cisco Catalyst 4500 Series for SMB Solution Brochure—**  
[http://www.cisco.com/en/US/products/hw/switches/ps4324/prod\\_brochure0900aecd8017a206.html](http://www.cisco.com/en/US/products/hw/switches/ps4324/prod_brochure0900aecd8017a206.html)
- **Cisco Catalyst 4500 Series Switches Design TechNotes—**  
[http://cco/en/US/partner/products/hw/switches/ps4324/tsd\\_products\\_support\\_design\\_technotes\\_list.html](http://cco/en/US/partner/products/hw/switches/ps4324/tsd_products_support_design_technotes_list.html)
- **Configuration Examples and Guides—**  
[http://cco/en/US/partner/products/hw/switches/ps4324/tsd\\_products\\_support\\_configure.html](http://cco/en/US/partner/products/hw/switches/ps4324/tsd_products_support_configure.html)



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