



Chapter 1: LAN Design



Scaling Networks

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Chapter 1 - Sections & Objectives

- 1.1 Campus Wired LAN Designs
 - Explain why it is important to design a scalable hierarchical network.
- 1.2 Selecting Network Devices
 - Select network devices based on feature compatibility and network requirements.



1.1 Campus Wired LAN Designs



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Campus Wired LAN Designs

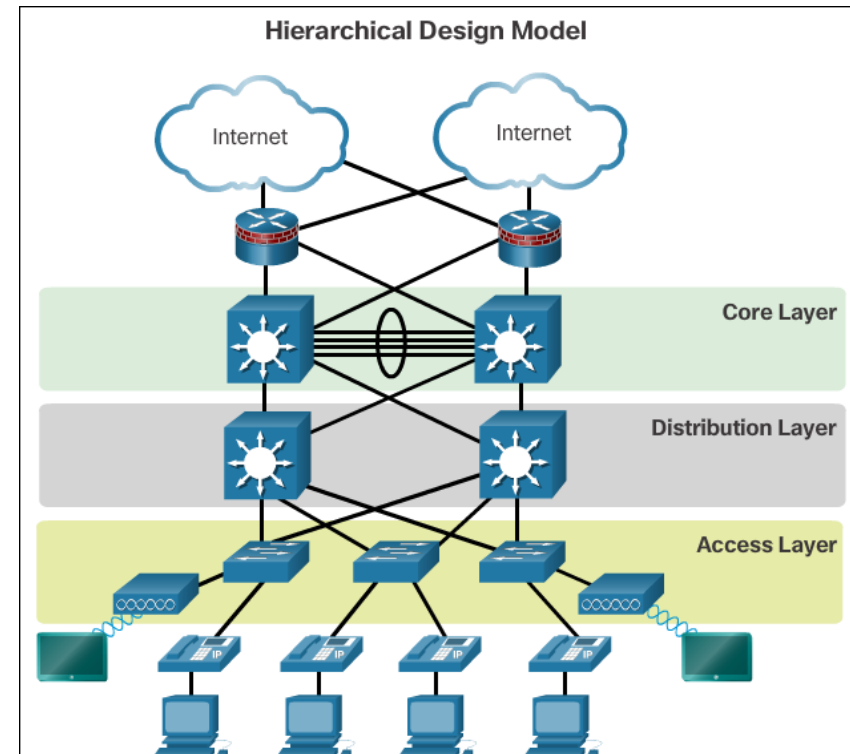
Cisco Validated Designs

■ The Need to Scale the Network

- All enterprise networks must: **support critical applications, support converged network traffic, support diverse business needs, and provide centralized administrative control.**
- Campus network designs include small networks that use a single LAN switch, up to very large networks with thousands of connections.

■ A **hierarchical LAN design** includes the access, distribution, and core layers:

- The **access layer** provides endpoints and users direct access to the network.
- The **distribution layer** aggregates access layers and provides connectivity to services.
- The **core layer** provides connectivity between distribution layers for large LAN environments.
- In smaller networks, the core layer can be collapsed.

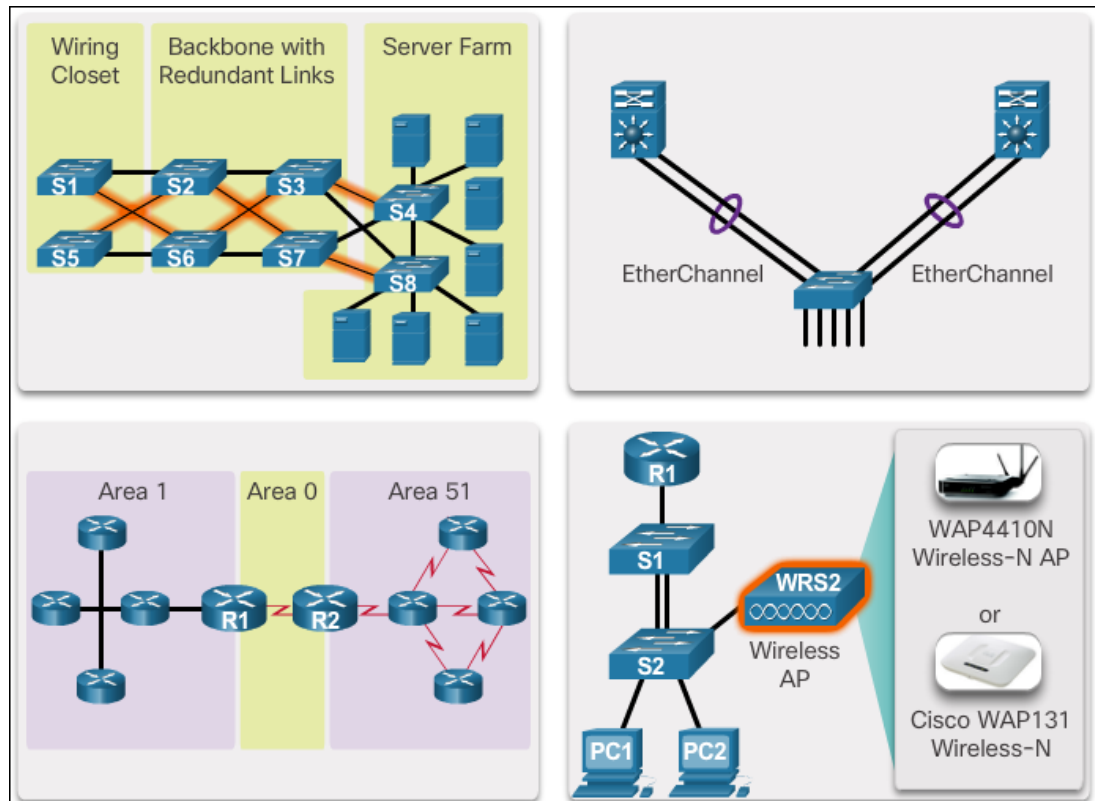




Campus Wired LAN Designs

Expanding the Network

- To support a large, medium or small network, the network designer must develop a strategy to enable the network to be available and to scale effectively and easily.
- One method of implementing redundancy is by installing **duplicate equipment** and providing **failover services for critical devices**. Another method of implementing redundancy is **redundant paths**. Knowledge of **STP** is required!
- Design a **hierarchical network** to include **modules** that can be added, upgraded, and modified, as necessary, without affecting the design of the other functional areas of the network.
- Create an **address strategy** that is hierarchical
- Limit **broadcasts** and **filter other undesirable traffic**

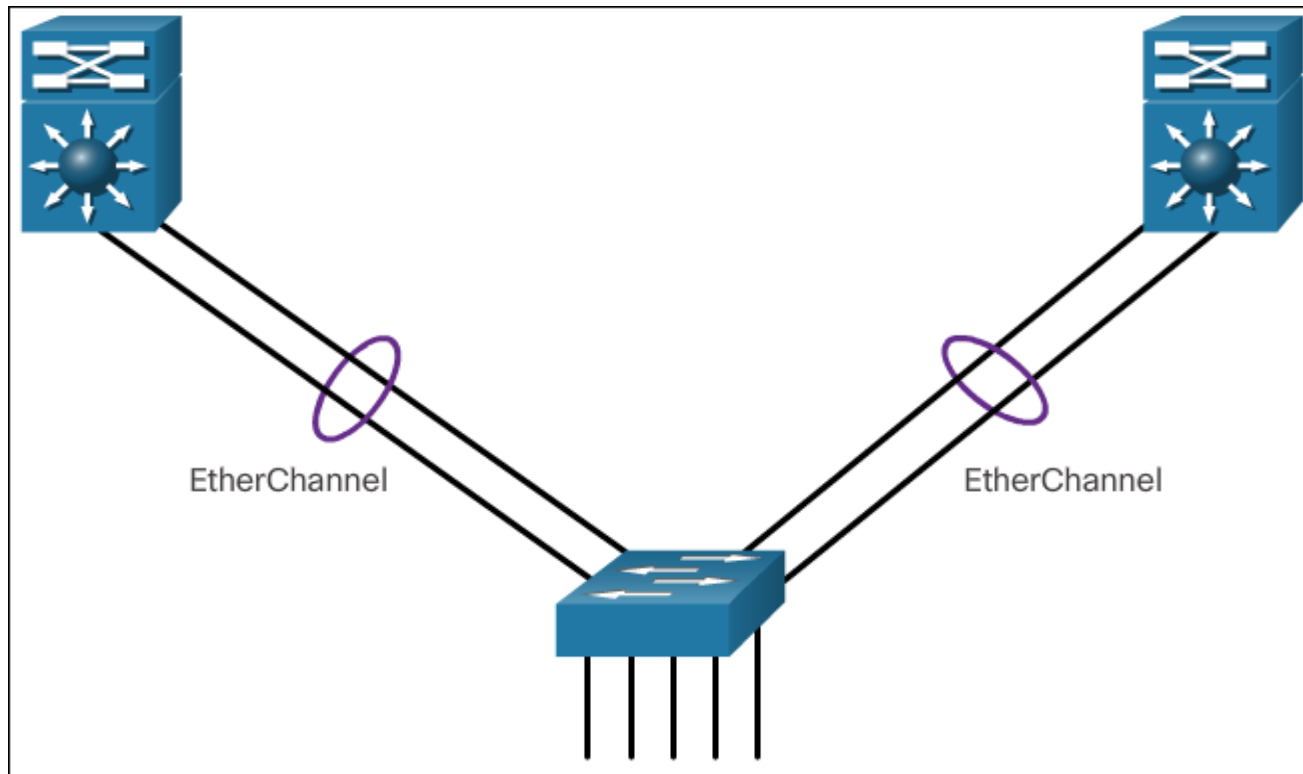




Campus Wired LAN Designs

Expanding the Network (Cont.)

- A **failure domain** is the **area of a network that is impacted when a critical device or network service experiences problems**. Smaller failure domains reduce the impact of a failure on company productivity. See examples in 1.1.2.3
- **Link aggregation** allows an administrator to increase the amount of bandwidth between devices by **creating one logical link made up of several physical links**. **EtherChannel** is a form of link aggregation used in switched networks.

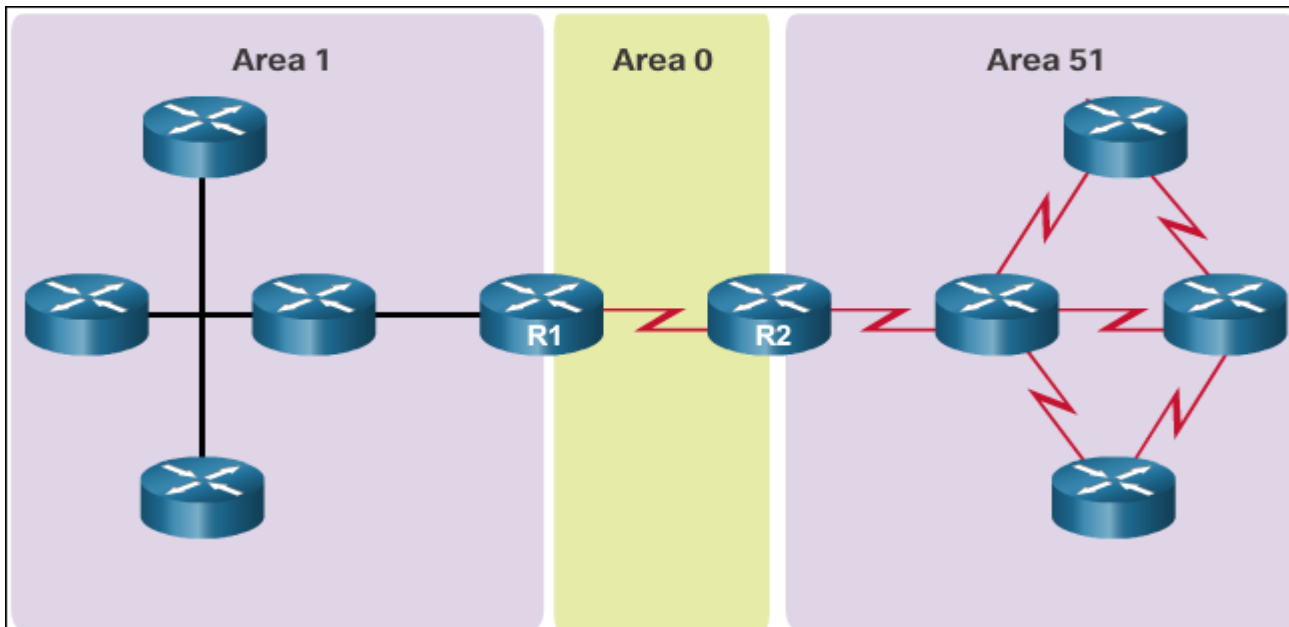




Campus Wired LAN Designs

Expanding the Network (Cont.)

- To communicate **wirelessly**, end devices require a wireless NIC that incorporates a radio transmitter/receiver and the required software driver to make it operational. Additionally, a wireless router or a wireless access point (AP) is required for users to connect.
- **Link-state routing protocols**, such as Open Shortest Path First (OSPF), **works well for larger hierarchical networks** where **fast convergence** is important. OSPF routers establish and maintain neighbor adjacency or adjacencies, with other connected OSPF routers.



**Practice
with
activity
1.1.2.7**



1.2 Selecting Network Devices



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Selecting Network Devices

Switch Platforms

Common Business Considerations When Selecting Switch Equipment:

- **Cost** - The cost of a switch will depend on the number and speed of the interfaces, supported features, and expansion capability.
- **Port Density** - Network switches must support the appropriate number of devices on the network.
- **Power** - It is now common to power access points, IP phones, and even compact switches using Power over Ethernet (PoE). In addition to PoE considerations, some chassis-based switches support redundant power supplies.
- **Reliability** - The switch should provide continuous access to the network.
- **Port Speed** - The speed of the network connection is of primary concern to end users.
- **Frame Buffers** - The ability of the switch to store frames is important in a network where there may be congested ports to servers or other areas of the network.
- **Scalability** - The number of users on a network typically grows over time; therefore, the switch should provide the opportunity for growth.



Campus LAN



Data Center



Cloud-Managed



Service Provider



Virtual Networking

Form factors: fixed, modular, stackable, non-stackable



Selecting Network Devices

Switch Hardware

- There are **five categories of switches** for enterprise networks: Campus LAN, Data Center, Cloud-Managed, Service Provider, and Virtual Networking.
- The **port density** of a switch refers to the **number of ports available on a single switch**. Fixed configuration switches typically support up to 48 ports on a single device. Modular switches can support very high-port densities through the addition of multiple switch port line cards.



24-port switch



48-port switch



Modular switch with up to 1000+ ports



Selecting Network Devices

Switch Hardware (Cont.)

- **Forwarding rates** define the processing capabilities of a switch by rating **how much data the switch can process per second**.
- **Wire speed** is the data rate that each Ethernet port on the switch is capable of attaining. Data rates can be 100 Mb/s, 1 Gb/s, 10 Gb/s, or 100 Gb/s.
- Less expensive, lower performing switches can be used at the access layer, and more expensive, higher performing switches can be used at the distribution and core layers, where the forwarding rate has a greater impact on network performance.

24-port Gigabit Ethernet Switch



Capable of switching 24 Gb/s of traffic

48-port Gigabit Ethernet Switch



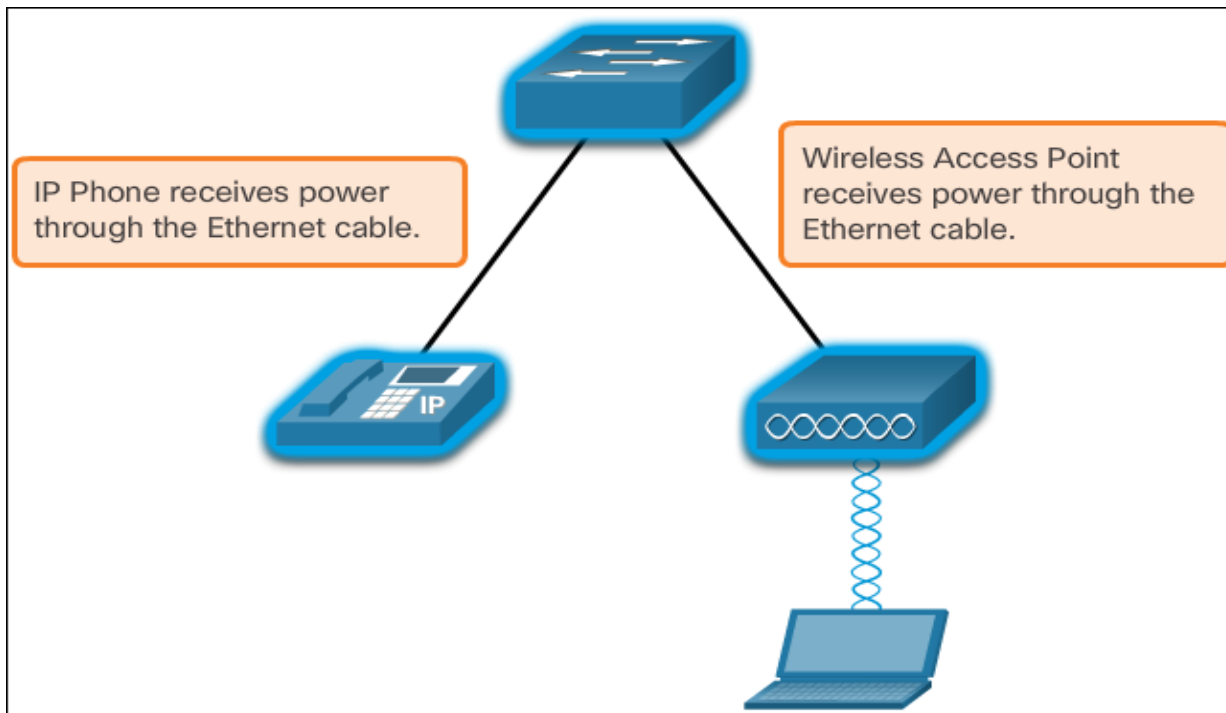
Capable of switching 48 Gb/s of traffic



Selecting Network Devices

Switch Hardware (Cont.)

- **Power over Ethernet (PoE)** allows the switch to deliver power to a device **over the existing Ethernet cabling** (allows more flexibility when installing wireless access points and IP phones). Expensive, use only if needed.
- **Multilayer switches** are typically deployed in the **core and distribution layers** of an organization's switched network. Multilayer switches are characterized by their **ability to build a routing table, support a few routing protocols, and forward IP packets at a rate close to that of Layer 2 forwarding**.



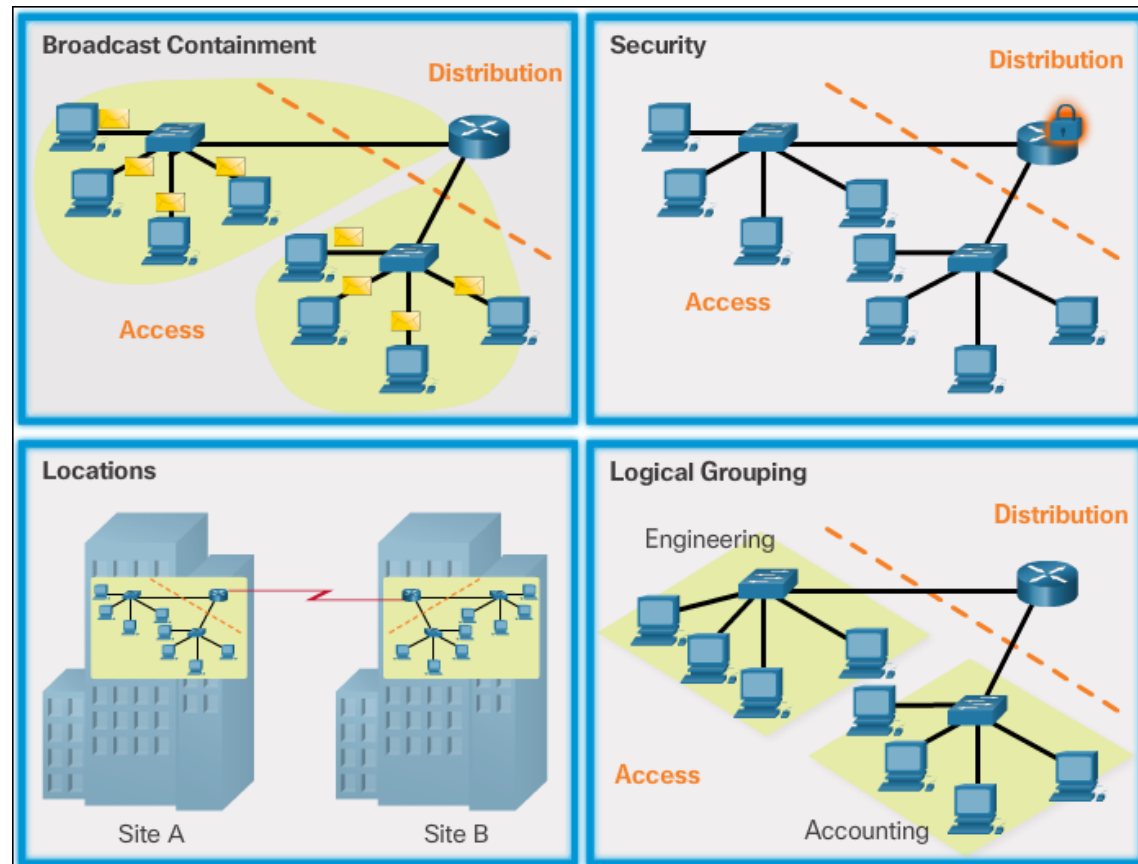
**Practice
with
activity
1.2.1.6**



Selecting Network Devices

Router Hardware (Cont.)

- **Routers play a critical role in networking by connecting homes and businesses to the Internet, interconnecting multiple sites within an enterprise network, providing redundant paths, and connecting ISPs on the Internet. They also act as a translator between different media types and protocols.**

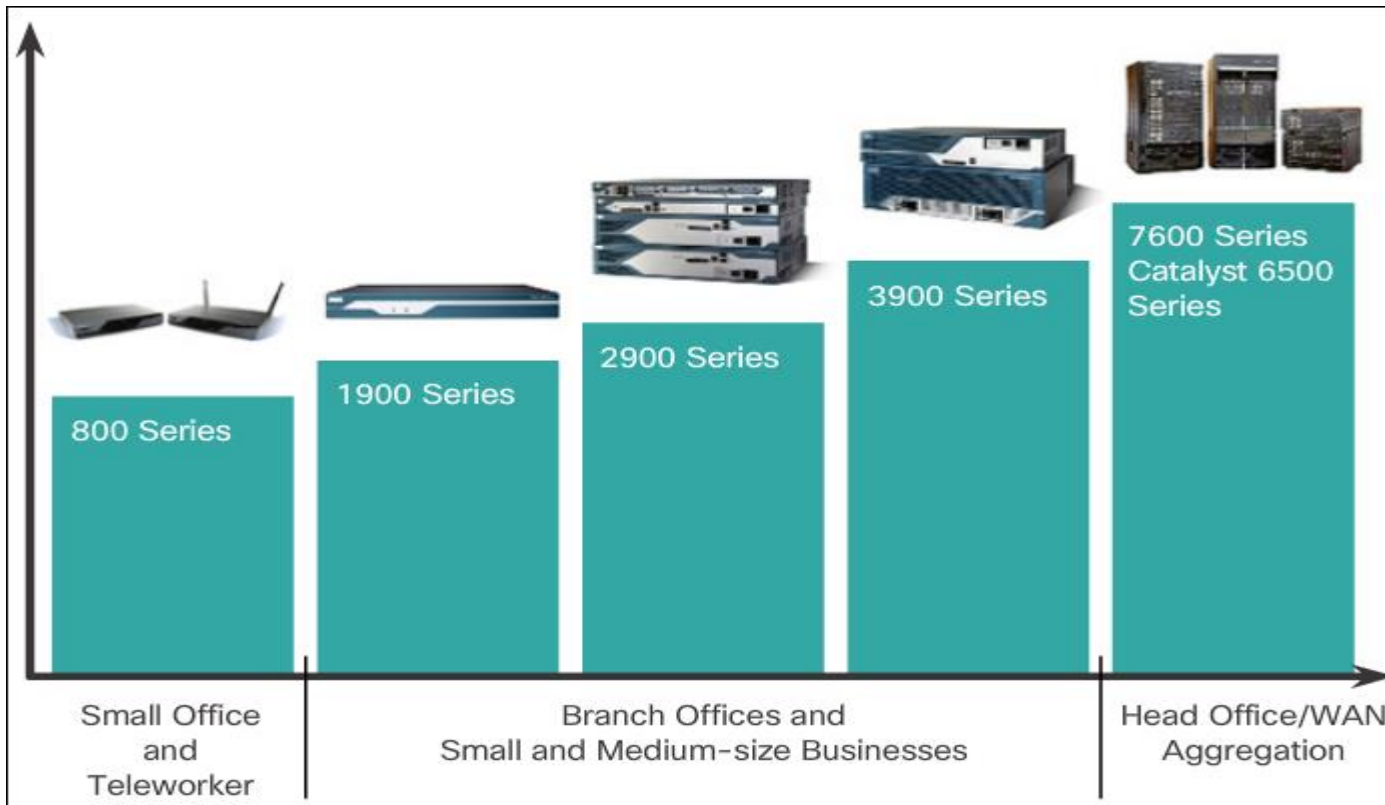




Selecting Network Devices

Router Hardware (Cont.)

- There are **three categories of routers**: Branch, Network Edge, and Service Provider. See the descriptions in 1.2.2.2.
- Routers also come in **many form factors**. Network administrators in an enterprise environment should be able to support a variety of routers, from a small desktop router to a rack-mounted or blade model.



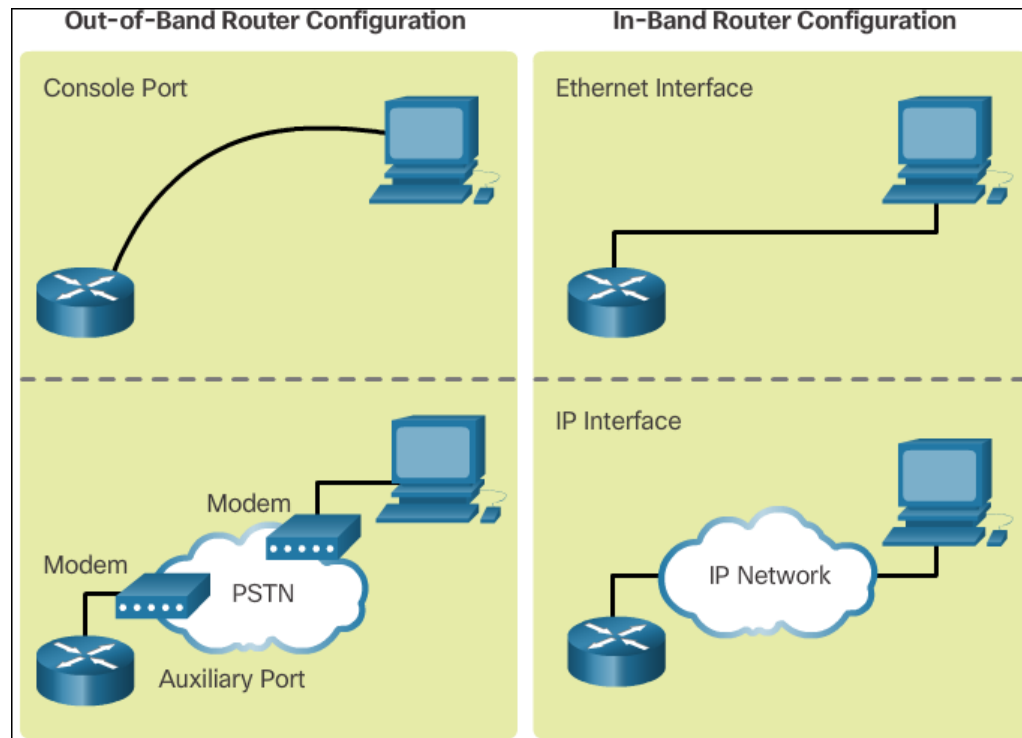
**Practice
with
activity
1.2.2.4**



Selecting Network Devices

Managing Devices

- **IOS** refers to the package of routing, switching, security, and other internetworking technologies integrated into a single multitasking operating system.
- **Out-of-band management** is used for initial configuration or when a network connection is unavailable: **console** / **aux**
- **In-band management** is used to monitor and make configuration changes to a network device over a network connection: **Telnet** / **SSH** / **HTTP(S)**





Selecting Network Devices

Managing Devices (Cont.)

- A basic router configuration includes the hostname for identification, passwords for security, assignment of IP addresses to interfaces for connectivity, and basic routing.
- Verify and save configuration changes using the **copy running-config startup-config** command.
- To clear the router configuration, use the **erase startup-config** command and then the **reload** command.

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# hostname R1
R1(config)# enable secret class
R1(config)# line console 0
R1(config-line)# password cisco
R1(config-line)# login
R1(config-line)# exec-timeout 0 0
R1(config-line)# line vty 0 15
R1(config-line)# password cisco
R1(config-line)# login
R1(config-line)# exit
R1(config)# service password-encryption
R1(config)# banner motd $ Authorized Access Only! $
R1(config)# interface GigabitEthernet0/0
R1(config-if)# description Link to LAN 1
R1(config-if)# ip address 172.16.1.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)# interface Serial0/0/0
R1(config-if)# description Link to R2
R1(config-if)# ip address 172.16.3.1 255.255.255.252
R1(config-if)# clock rate 128000
R1(config-if)# no shut
R1(config-if)# interface Serial0/0/1
R1(config-if)# description link to R3
R1(config-if)# ip address 192.168.10.5 255.255.255.252
R1(config-if)# no shut
R1(config-if)# exit
R1(config)# router rip
R1(config-router)# version 2
R1(config-router)# network 172.16.0.0
R1(config-router)# network 192.168.10.0
R1(config-router)# exit
R1(config)# end
R1#
```



Selecting Network Devices

Managing Devices (Cont.)

- Some of the most commonly used IOS commands to display and verify the operational status of the router and related IPv4 network functionality are
 - **show ip protocols** - Displays information about the routing protocols configured.
 - **show ip route** - Displays routing table information, including: routing codes, known networks, administrative distance and metrics, how routes were learned, next hop, static routes, and default routes.
 - **show interfaces** - Displays interfaces with line (protocol) status, bandwidth, delay, reliability, encapsulation, duplex, and I/O statistics.
 - **show ip interfaces** - Displays interface information, including: protocol status, the IPv4 address, if a helper address is configured, and whether an ACL is enabled on the interface.
 - **show ip interface brief** - Displays all interfaces with IPv4 addressing information and interface and line protocols status.
 - **show protocols** - Displays information about the routed protocol that is enabled, and the protocol status of interfaces.



Selecting Network Devices

Managing Devices (Cont.)

- Basic **switch** CLI commands:
- Hostname
- Passwords
- In-Band access requires the switch to have an SVI IP address (assigned to the management VLAN).
- Save configuration – **copy running-config startup-config** command.
- To clear switch – **erase startup-config** and **delete flash:vlan.dat**, and then **reload**.

```
Switch# enable
Switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)# hostname S1
S1(config)# banner motd %Unauthorized access prohibited%
S1(config)# enable password cisco
S1(config)# enable secret class
S1(config)# line con 0
S1(config-line)# password cisco
S1(config-line)# login
S1(config-line)# line vty 0 4
S1(config-line)# password cisco
S1(config-line)# login
S1(config-line)# interface vlan 1
S1(config-if)# ip address 192.168.1.5 255.255.255.0
S1(config-if)# no shutdown
S1(config-if)# exit
S1(config)# ip default-gateway 192.168.1.1
S1(config)# interface fa0/2
S1(config-if)# switchport mode access
S1(config-if)# switchport port-security
S1(config-if)# interface fa0/3
S1(config-if)# speed 10
S1(config-if)# duplex half
S1(config-if)# end
```



Selecting Network Devices

Managing Devices (Cont.)

- Commonly used switch **show** commands:
- **show port-security** – Displays any ports with security enabled.
- **show port-security address** – Displays all secure MAC addresses.
- **show interfaces** – Displays detailed information about interfaces.
- **show mac-address-table** – Displays all MAC addresses the switch has learned.
- **show cdp neighbors** – Displays all directly connected Cisco devices.



Chapter 1: Summary

This chapter:

- Introduces the **hierarchical network design model** that divides network functionality into the **access layer**, the **distribution layer**, and the **core layer**.
- Defines how routers and multilayer switches are used to limit failure domains.
- Explains that a good network design includes a scalable IP scheme, fast converging and scalable routing protocols, appropriate Layer 2 protocols and devices that are modular or easily upgraded.
- Identifies that a mission-critical server should have a connection to two different access layer switches. It should also have redundant modules and backup power.
- Recognizes that routers and switches should be selected from the appropriate categories to meet the network's requirements.

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