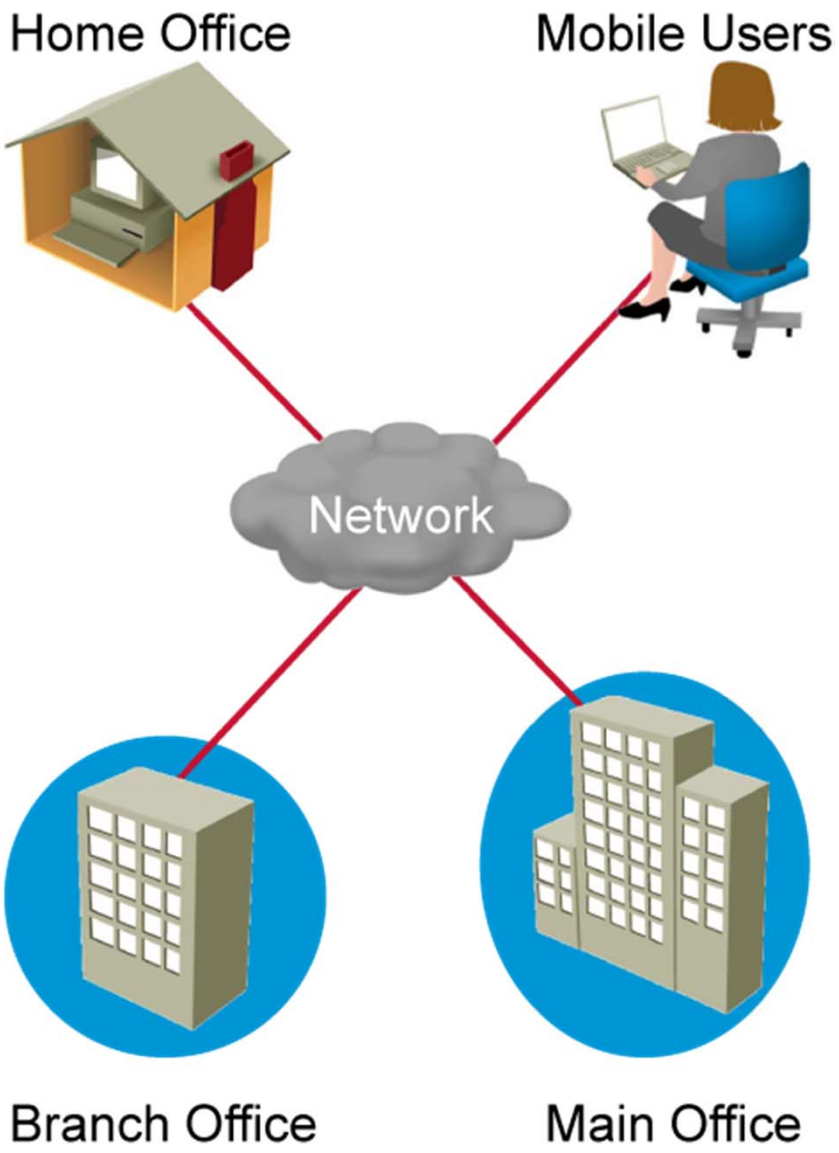
Building a Simple Network

Interconnecting Cisco Networking Devices, Part 1 (ICND1) v2.0

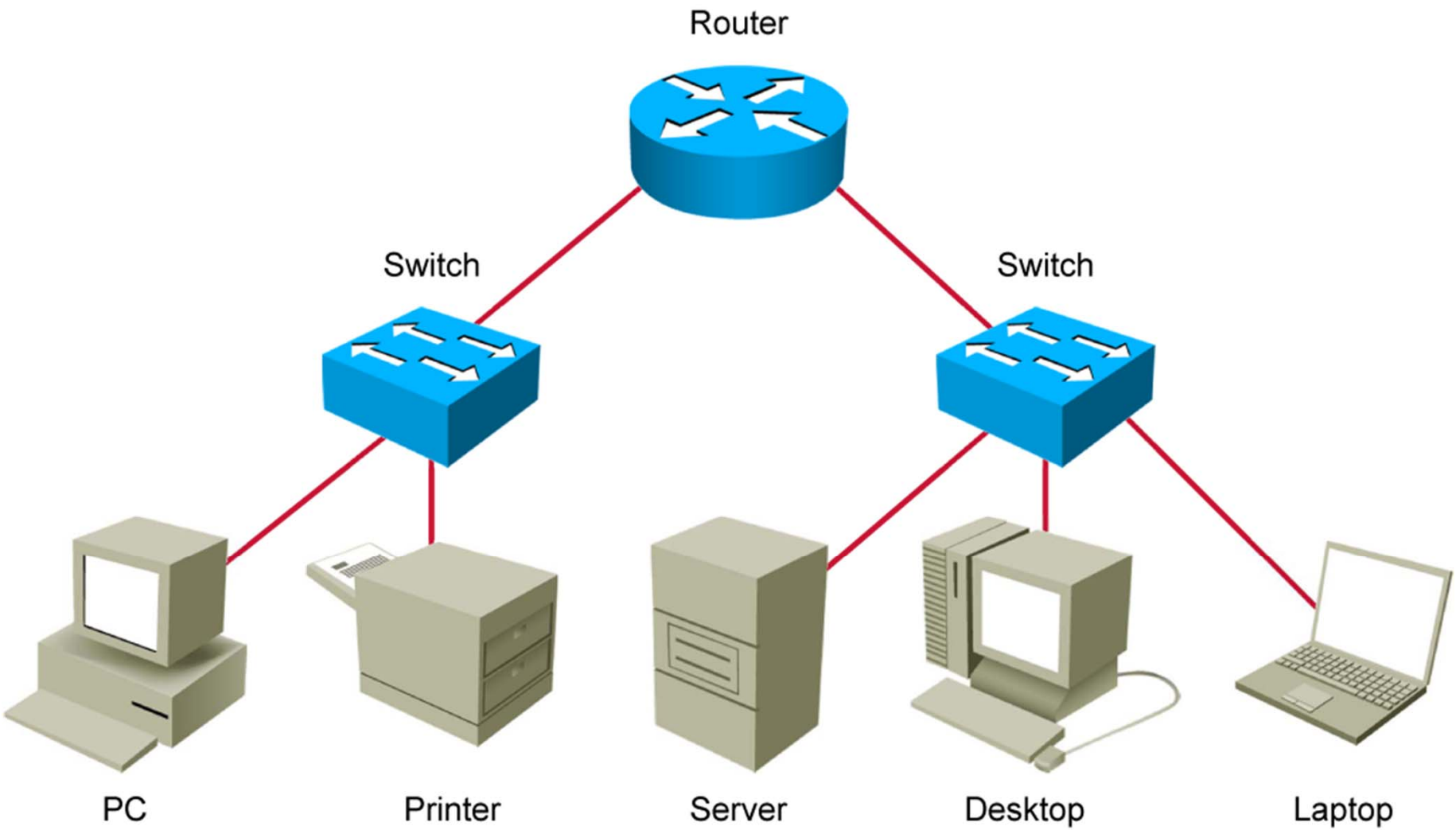
Exploring the Functions of Networking

Building a Simple Network

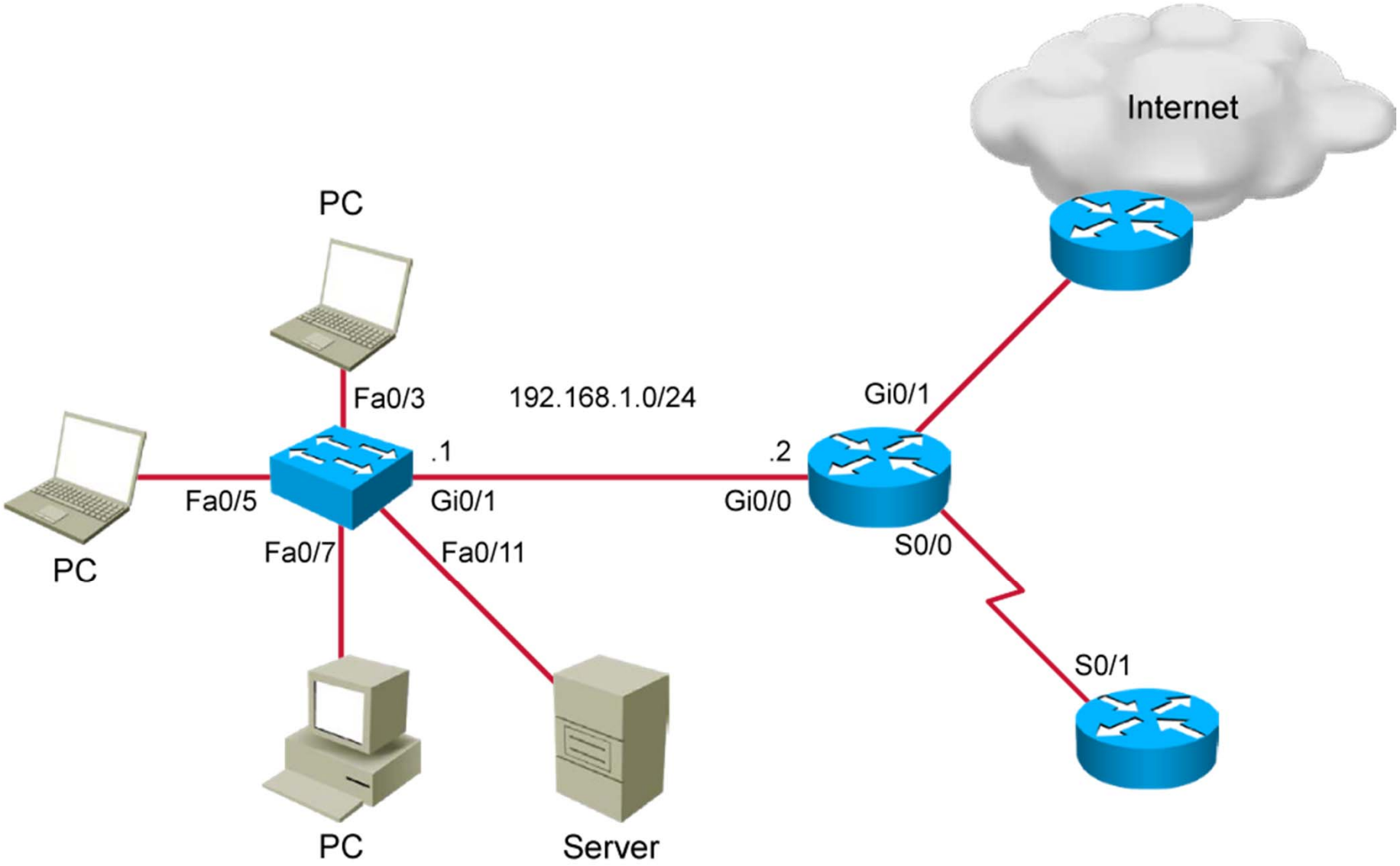
What Is a Network?



Physical Components of a Network

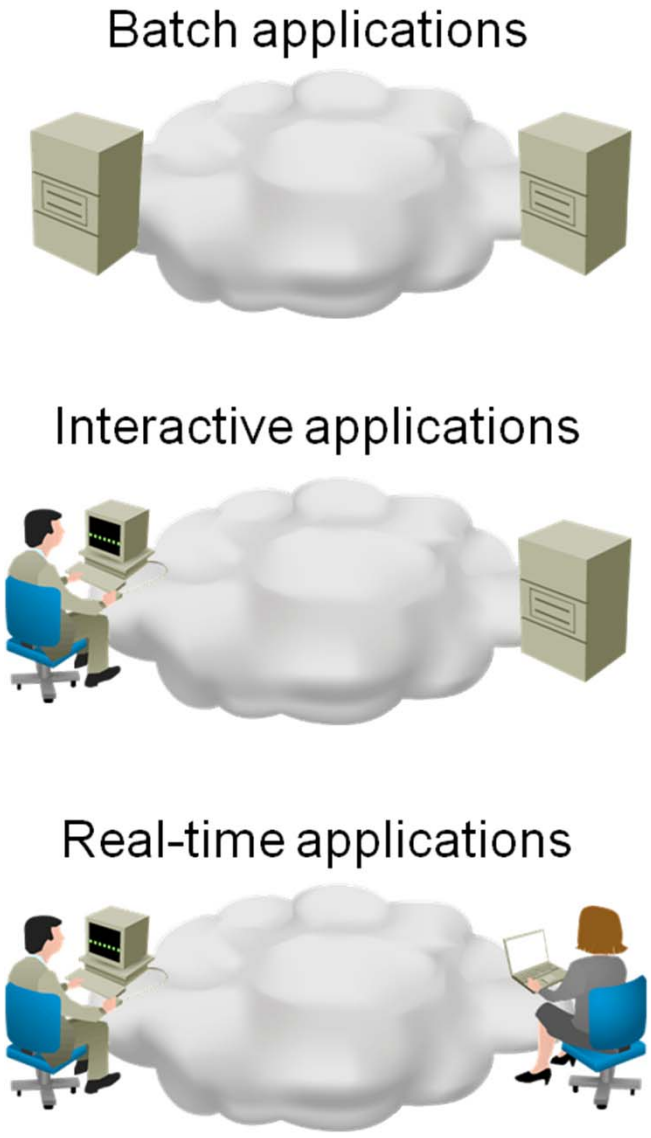


Interpreting a Network Diagram



Impact of User Applications on the Network

- Batch applications:
  - FTP, TFTP, inventory updates
  - No direct human interaction
  - Bandwidth important, but not critical
- Interactive applications:
  - Inventory inquiry, database update
  - Human-to-machine interaction
  - Human waiting for response, response time important but not critical, unless wait becomes excessive
- Real-time applications:
  - VoIP, video
  - Human-to-human interaction
  - End-to-end latency critical

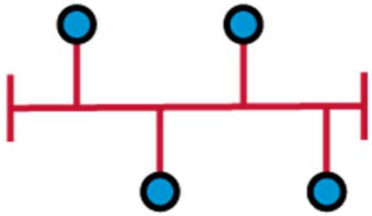


Characteristics of a Network

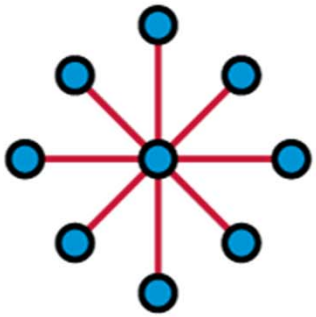
- Topology
- Speed
- Cost
- Security
- Availability
- Scalability
- Reliability

Physical Topologies

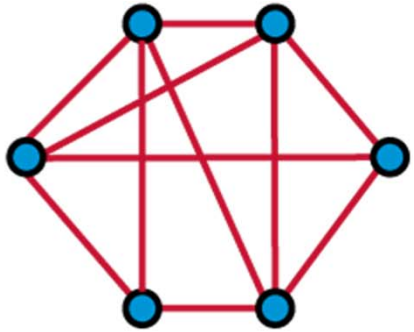
- Physical layout of the devices and cabling
- Three primary categories (bus, star, and mesh)



Bus Topology



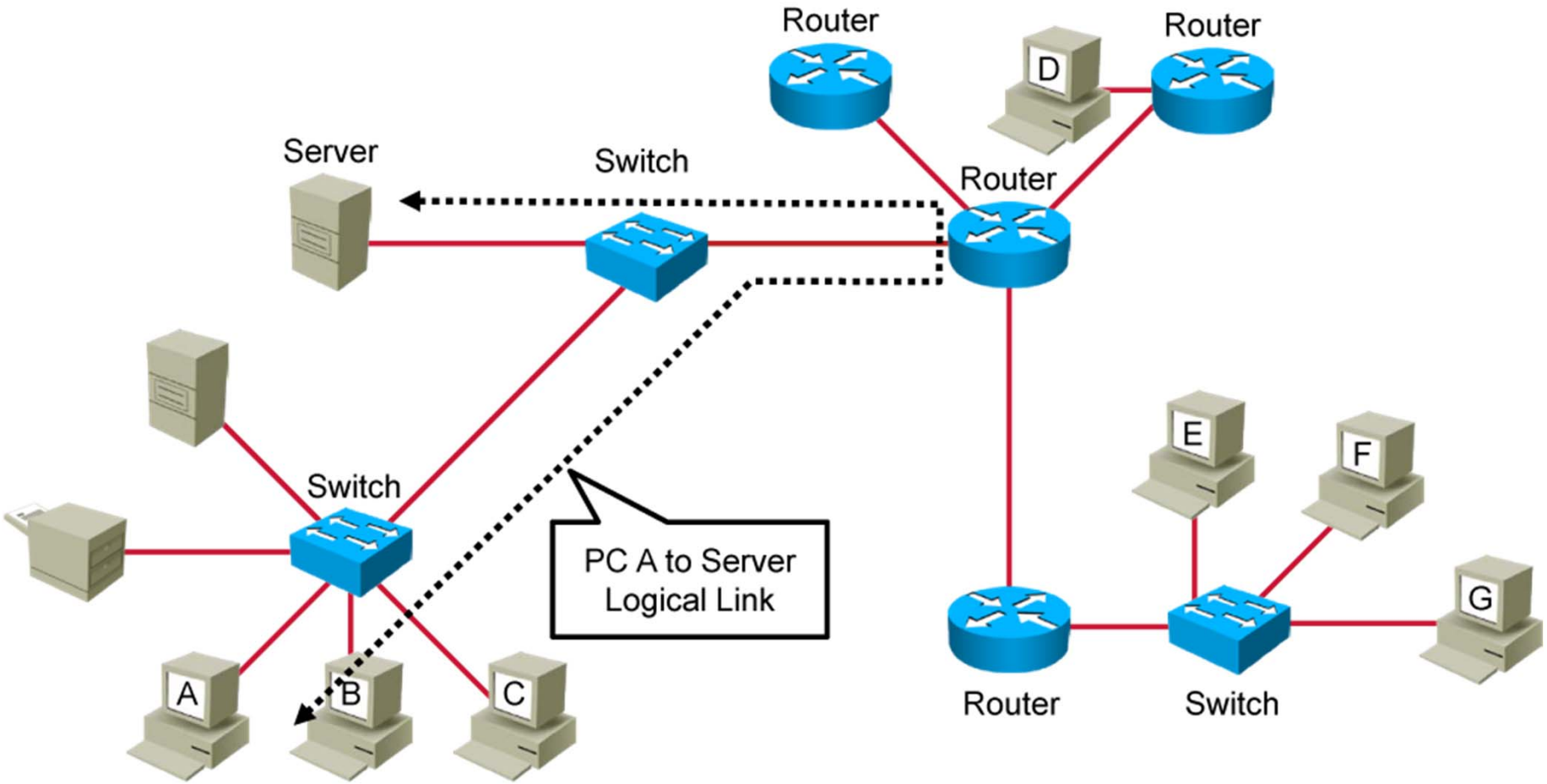
Star Topology



Mesh Topology

Logical Topologies

Logical paths that the signals use to travel from one point on the network to another



Summary

- A network is a connected collection of devices that can communicate with each other.
- There are four major categories of physical components in a computer network: computers, interconnections, switches, and routers.
- Icons are used to represent the components of a network in a network diagram.
- Common network user applications can be grouped into batch, interactive, and real-time applications.
- The ways in which networks can be described include characteristics that address network performance and structure: topology, speed, cost, security, availability, scalability, and reliability.
- A physical topology describes the layout for wiring the physical devices. A logical topology describes how information flows through a network.

Understanding the Host-to-Host Communications Model

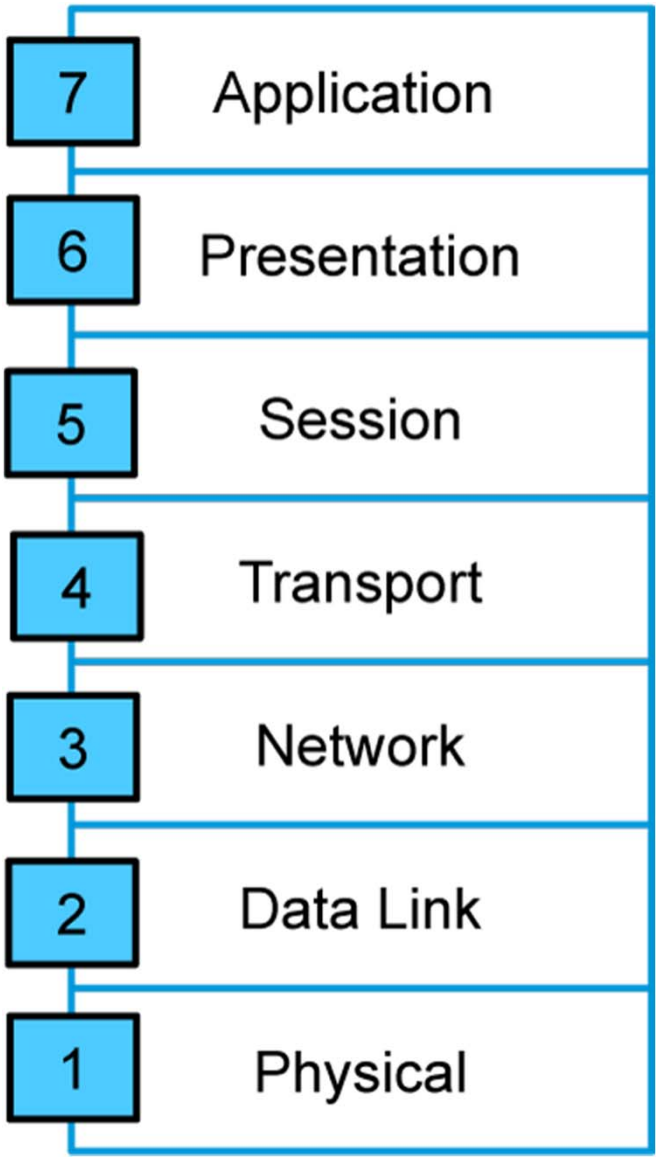
Building a Simple Network

Introducing Host-to-Host Communications

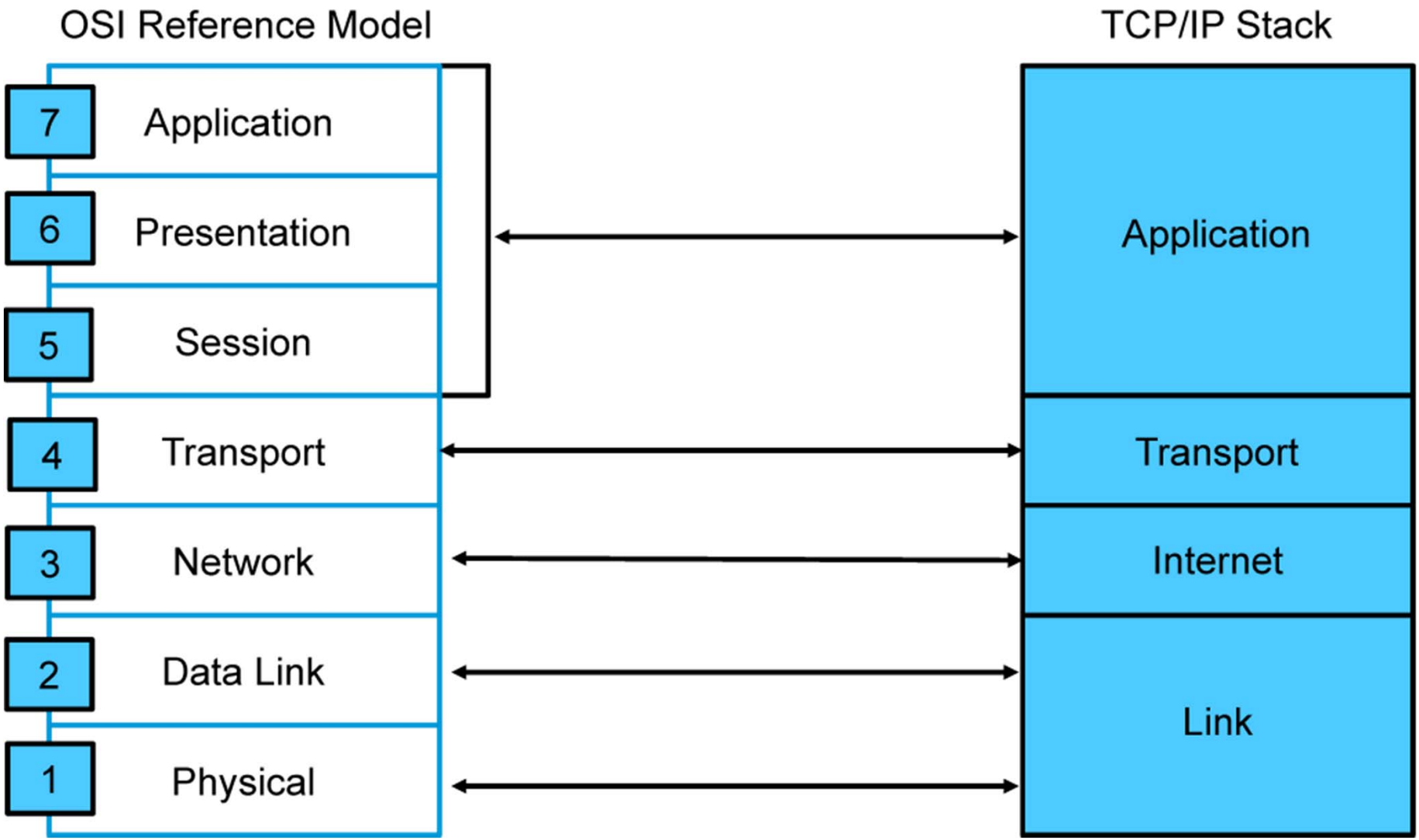
Two different types of host-to-host models:

- Older model:
  - Proprietary
  - Applications and combinations of software controlled by one vendor
- Standards-based model:
  - Multivendor software
  - Layered approach
  - Examples: OSI, TCP/IP

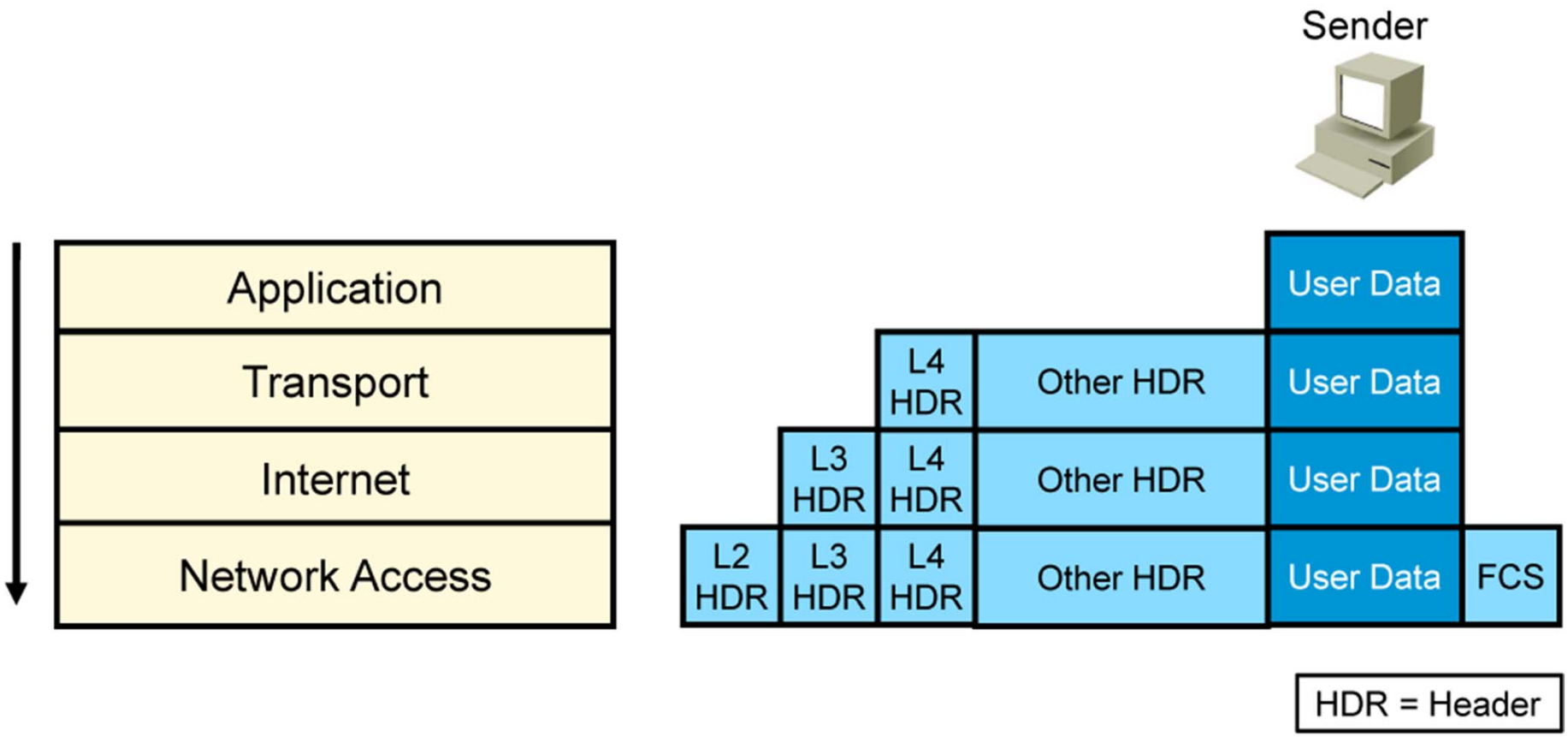
OSI Reference Model



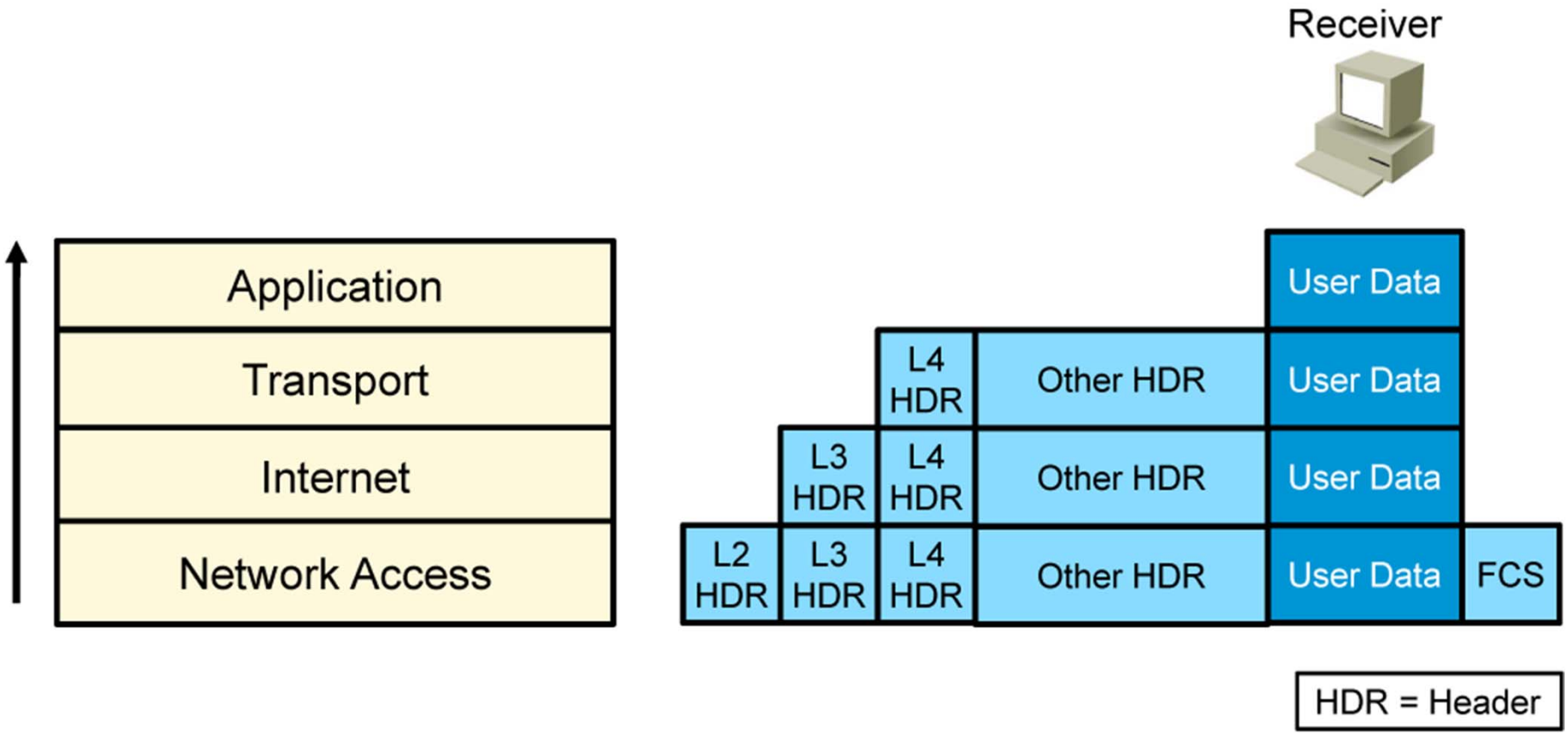
TCP/IP Protocol Suite



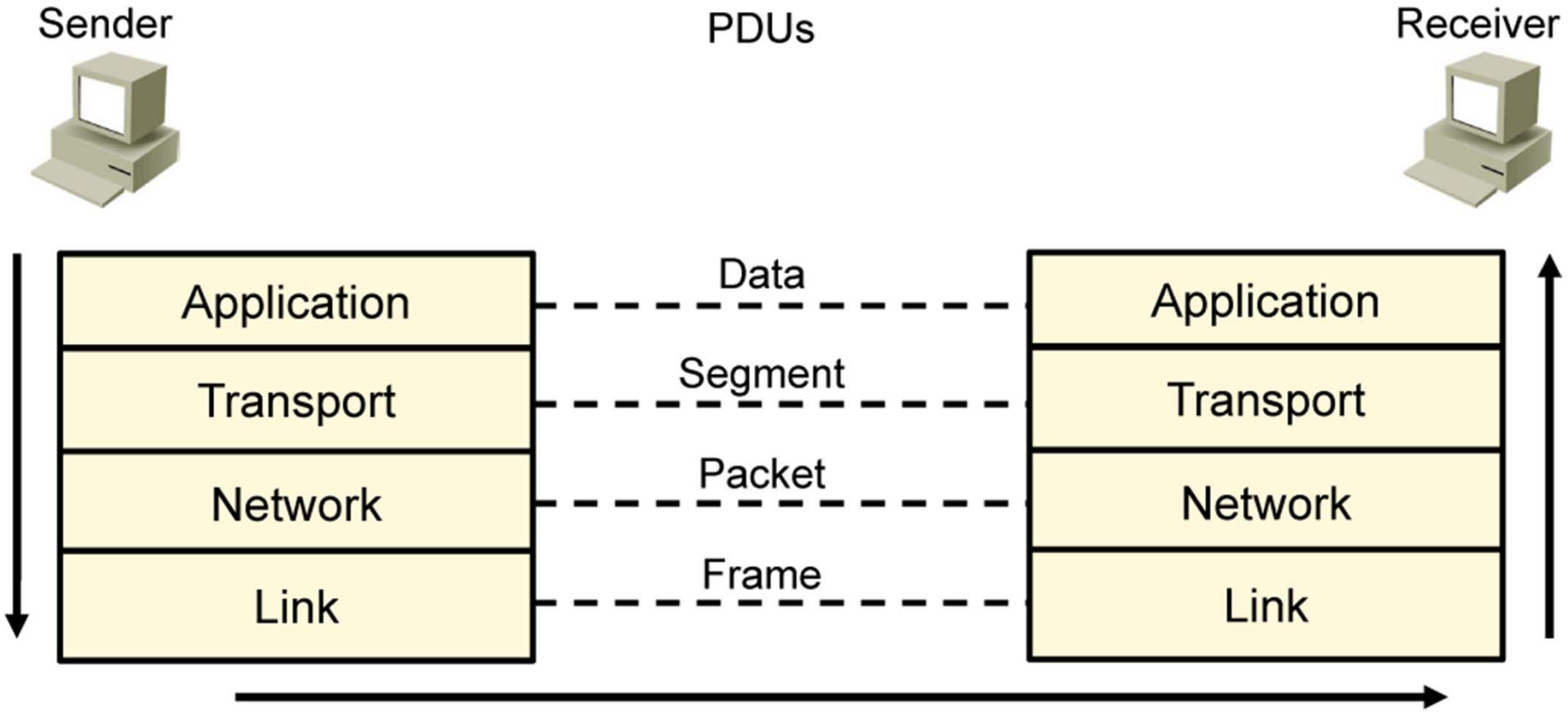
Data Encapsulation



Data De-Encapsulation



Peer-to-Peer Communications



Summary

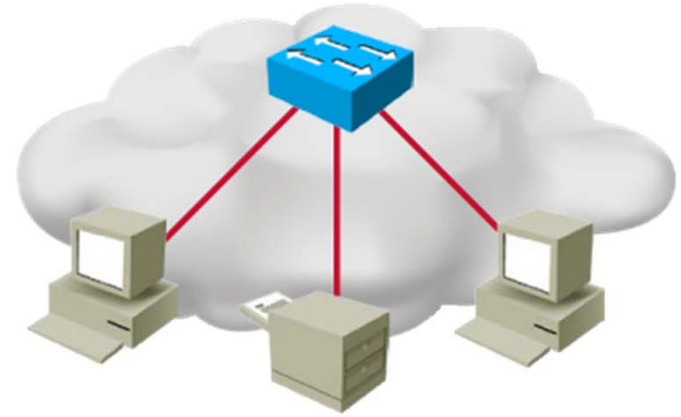
- Successful communication between hosts on a network requires the interaction of many different protocols.
- The TCP/IP protocol suite, the most commonly used protocol model, enables an understanding of how networks function.
- TCP/IP organizes the functions that must occur for communications to be successful into four layers (link, Internet, transport, and application).
- As application data within the TCP/IP suite is passed down the protocol stack on its way to be transmitted across the network media, various protocols add information to it at each level. This process is commonly known as the encapsulation process. The process is reversed at the receiving host and is known as de-encapsulation.
- During the process of peer-to-peer communication, the protocols at each layer exchange packets of information called PDUs. Protocols, which are implemented on the sending and receiving hosts, interact to provide end-to-end delivery of applications over a network.

Introducing LANs

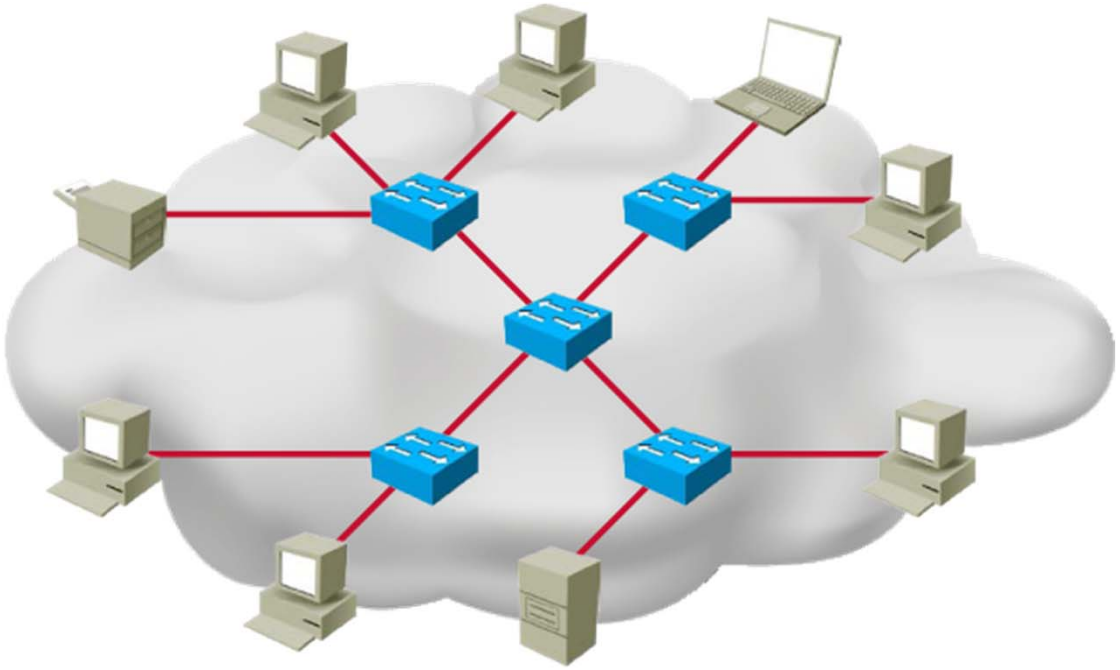
Building a Simple Network

Local Area Networks

A LAN is a network of computers and other components that are located relatively close together in a limited area.



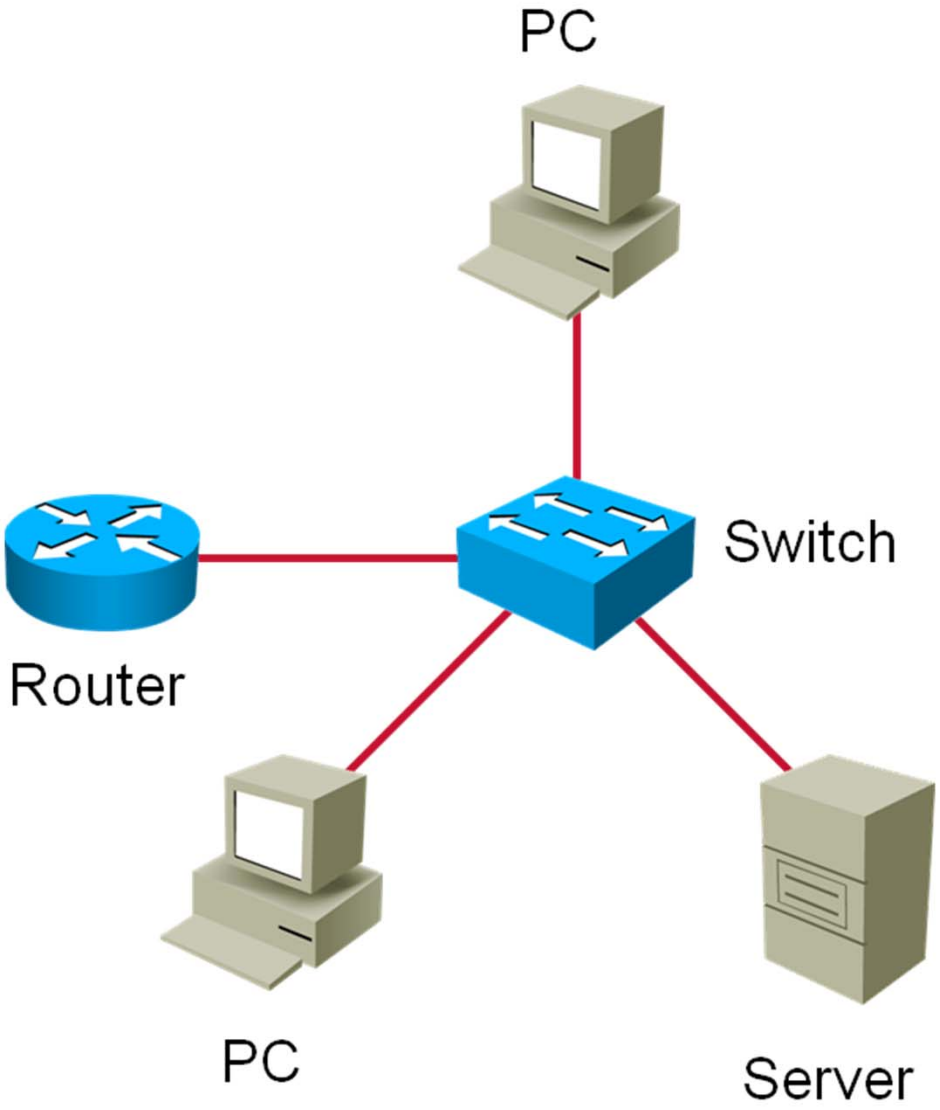
Small Office LAN



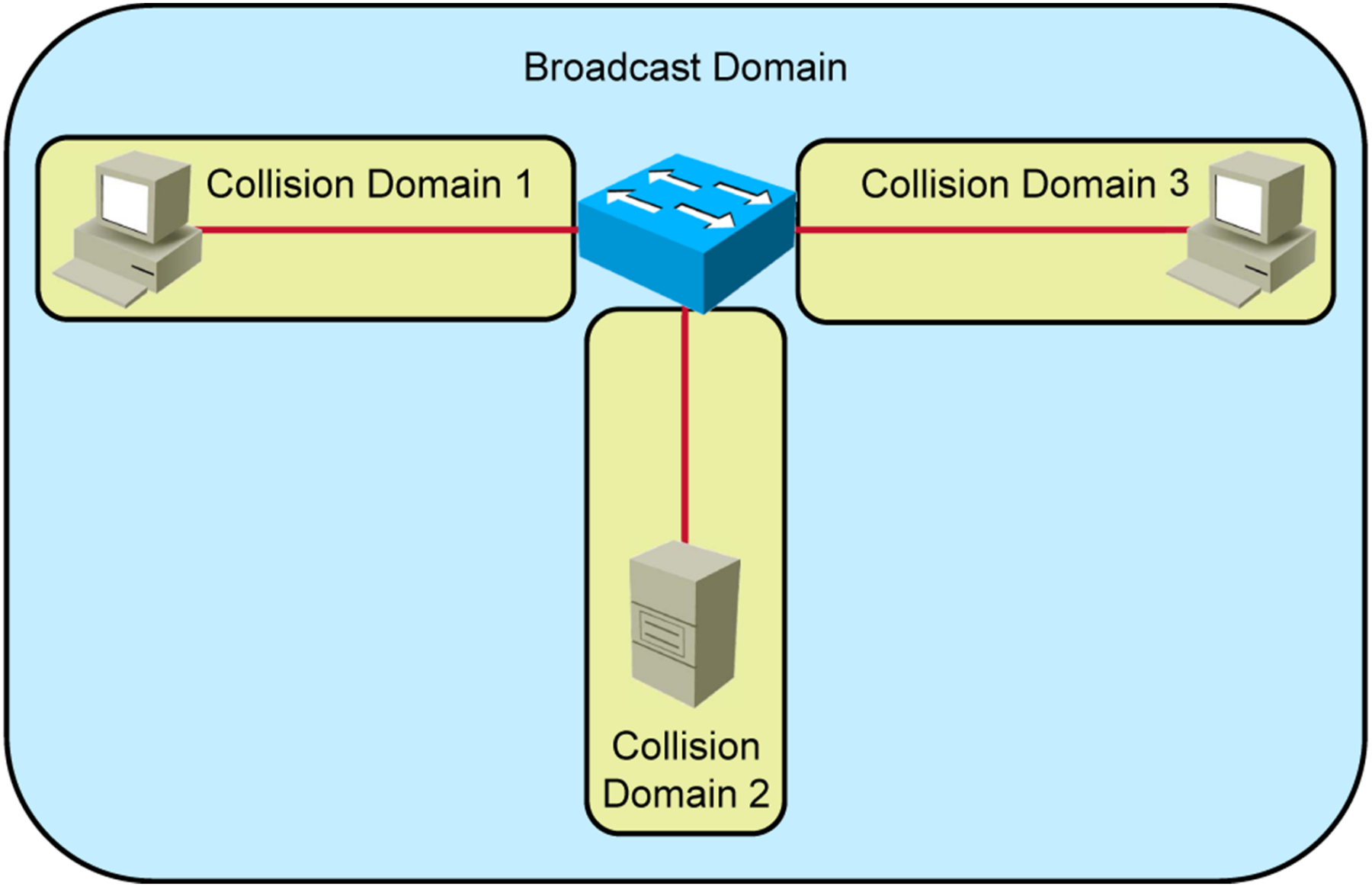
Large Office LAN

LAN Components

- Computers:
  - PCs
  - Servers
- Interconnections:
  - NICs
  - Media
- Network devices:
  - Switches
  - Routers
- Protocols:
  - Ethernet
  - IP
  - ARP
  - DHCP



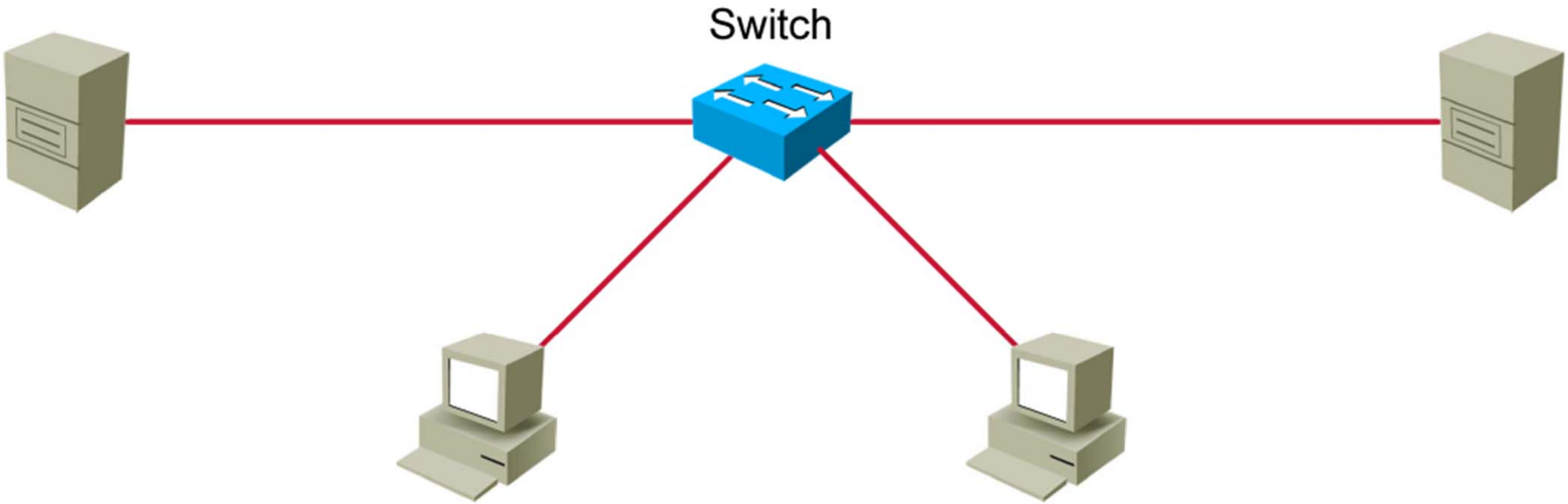
Need for Switches



Need for Switches (Cont.)

Switches have these functions:

- Operate at the link layer of the TCP/IP protocol suite
- Forward, filter, or flood frames based on MAC table entries
- Have many full-duplex ports to segment a large LAN into many smaller segments
- Are fast and support various port speeds



Switches

LAN switch characteristics:

- High port density
- Large frame buffers
- Mixture of port speeds
- Fast internal switching
- Low per-port cost

Summary

- A LAN is a network that is located in a limited area, with the computers and other components that are part of this network located relatively close together.
- Regardless of its size, several fundamental components are required for the operation of a LAN, including computers, interconnections, network devices, and protocols.
- Ethernet switches enable the exchange of frames between devices. They selectively forward individual frames from a receiving port to the destination port.
- Switches support high-throughput performance, high port density, and have low per-port cost.

Operating Cisco IOS Software

Building a Simple Network

Cisco IOS Software Features and Functions

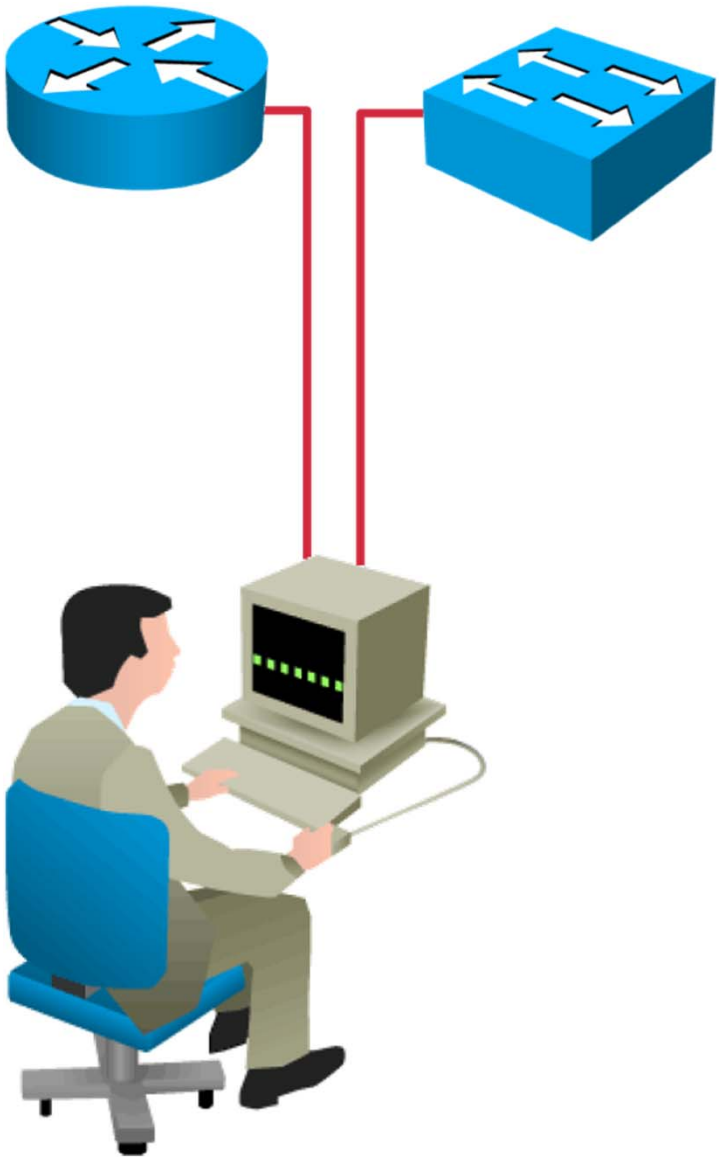
Cisco IOS Software delivers networking services in Cisco products:

- Connectivity, for high-speed traffic between devices
- Security, to control access and prohibit unauthorized network use
- Scalability, to add interfaces and capability for network growth
- Reliability, to ensure access to networked resources
- Consistency, to experience among various device types

Cisco IOS CLI Functions

The CLI is used to enter commands.

- Operations vary on different internetworking devices.
- Users type or copy-and-paste entries in the console command modes.
- Command modes have distinctive prompts.
- Pressing **Enter** instructs the device to parse (translate) and execute the command.
- The two primary EXEC modes are user mode and privileged mode.



User EXEC Mode

User EXEC mode allows limited examination of a switch or a router

- Command prompt: **hostname>**

```
Switch>?
Exec commands:
  access-enable    Create a temporary Access-List entry
  access-profile   Apply user-profile to interface
  clear            Reset functions
  connect          Open a terminal connection
  crypto           Encryption related commands
  disable          Turn off privileged commands
  disconnect       Disconnect an existing network connection
  enable           Turn on privileged commands
  exit             Exit from the EXEC
  <output omitted>
```

Privileged EXEC Mode

Privileged EXEC mode allows detailed examination of a switch or a router

- Enables configuration and debugging
- Prerequisite for other configuration modes
- Change from user EXEC mode to privileged EXEC mode using the **enable** command

Privileged EXEC Mode (Cont.)

- Command prompt: **hostname#**

```
Switch>enable
Switch#?
Exec commands:
  access-enable    Create a temporary Access-List entry
  access-profile   Apply user-profile to interface
  access-template  Create a temporary Access-List entry
  archive          Manage archive files
  beep             Blocks Extensible Exchange Protocol commands
  call-home        Call-Home commands
  cd               Change current directory
  clear            Reset functions
  clock            Manage the system clock
  cns              CNS agents
  <output omitted>
```

Help Functions in the CLI

Type of CLI Help	Description
Context-sensitive help	Provides a list of commands and the arguments that are associated with a specific command
Console error messages	Identifies problems with commands that are incorrectly entered so that they can be altered or corrected

Help Functions in the CLI (Cont.)

This sequence of commands shows how CLI context-sensitive help can be used:

```
SwitchX#cl?
clear clock
SwitchX#clock ?
   set   Set the time and date
SwitchX#clock set ?
   hh:mm:ss  Current time
SwitchX#clock set 19:50:00 ?
   <1-31>  Day of the month
   MONTH  Month of the year
SwitchX#clock set 19:50:00 25 June ?
   <1993-2035> Year
SwitchX#clock set 19:50:00 25 June 2012
SwitchX#
```

CLI Error Messages

```
SwitchX#c
% Ambiguous command:'c'
```

- Not enough characters were entered.

```
SwitchX#clock set
% Incomplete command
SwitchX#clock set 19:50:00
% Incomplete command
```

- Required arguments or keywords were left off the end of the command.

```
SwitchX#>clock set 19:50:00 25 6
                            ^
% Invalid input detected at "^" marker
```

- The caret (^) indicates where the command interpreter cannot decipher the command.

Managing Cisco IOS Configurations

There are two general types of configuration:

- **Running configuration:** This state reflects the current configuration of the device.
- **Startup configuration:** This file is used to load the saved configuration after powering up. If no configuration is present, enter setup mode or load a blank configuration.

Managing Cisco IOS Configurations (Cont.)

This is how you investigate the current running configuration (RAM):

```
Switch#show running-config
Building configuration...

Current configuration : 1707 bytes
!
! Last configuration change at 04:45:43 UTC Fri Aug 17 2012
! NVRAM config last updated at 04:45:43 UTC Fri Aug 17 2012
!
version 15.0
no service pad
service timestamps debug datetime msec
<output omitted>
```

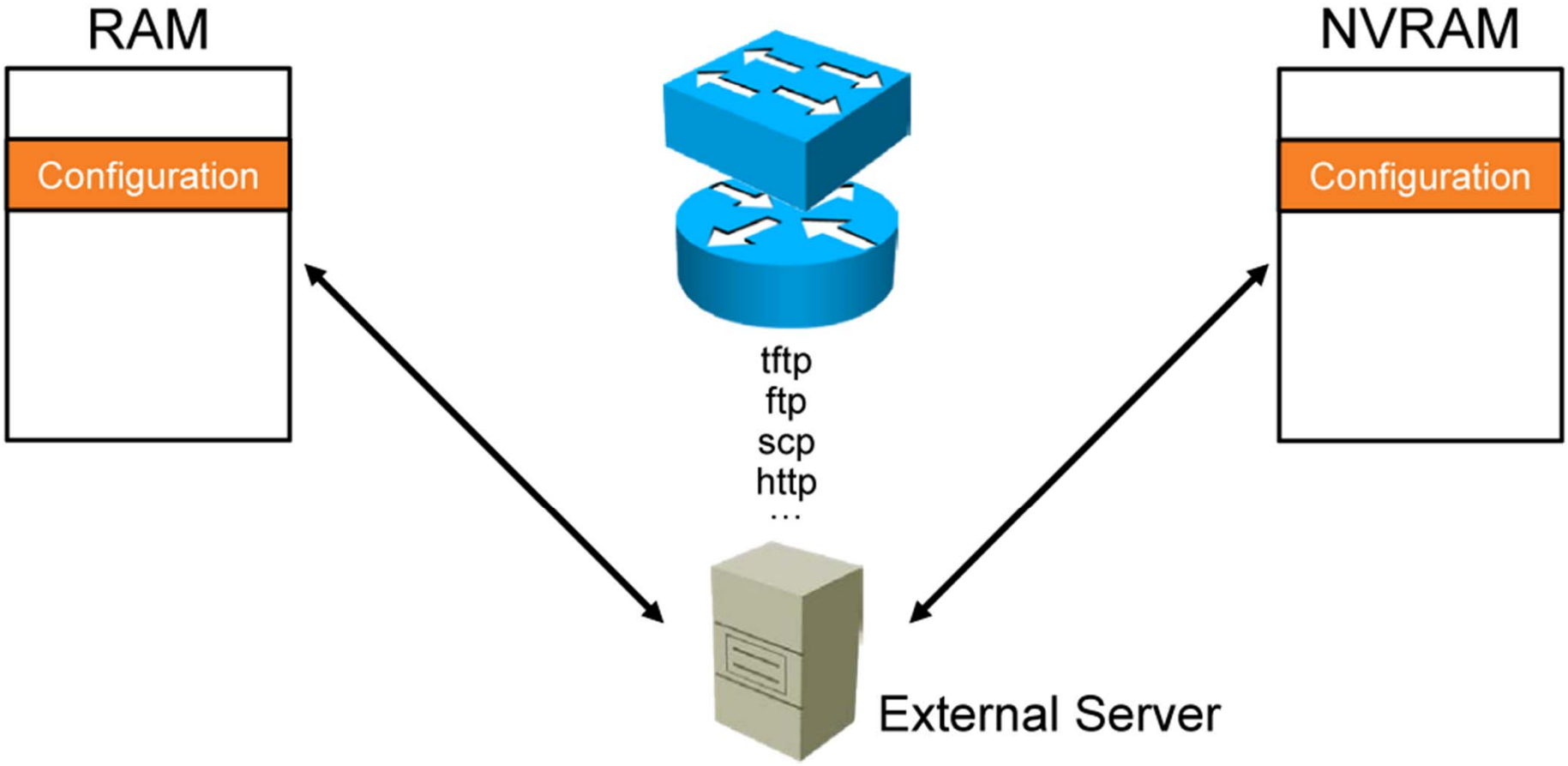
Managing Cisco IOS Configuration (Cont.)

This is how you investigate the saved configuration (NVRAM):

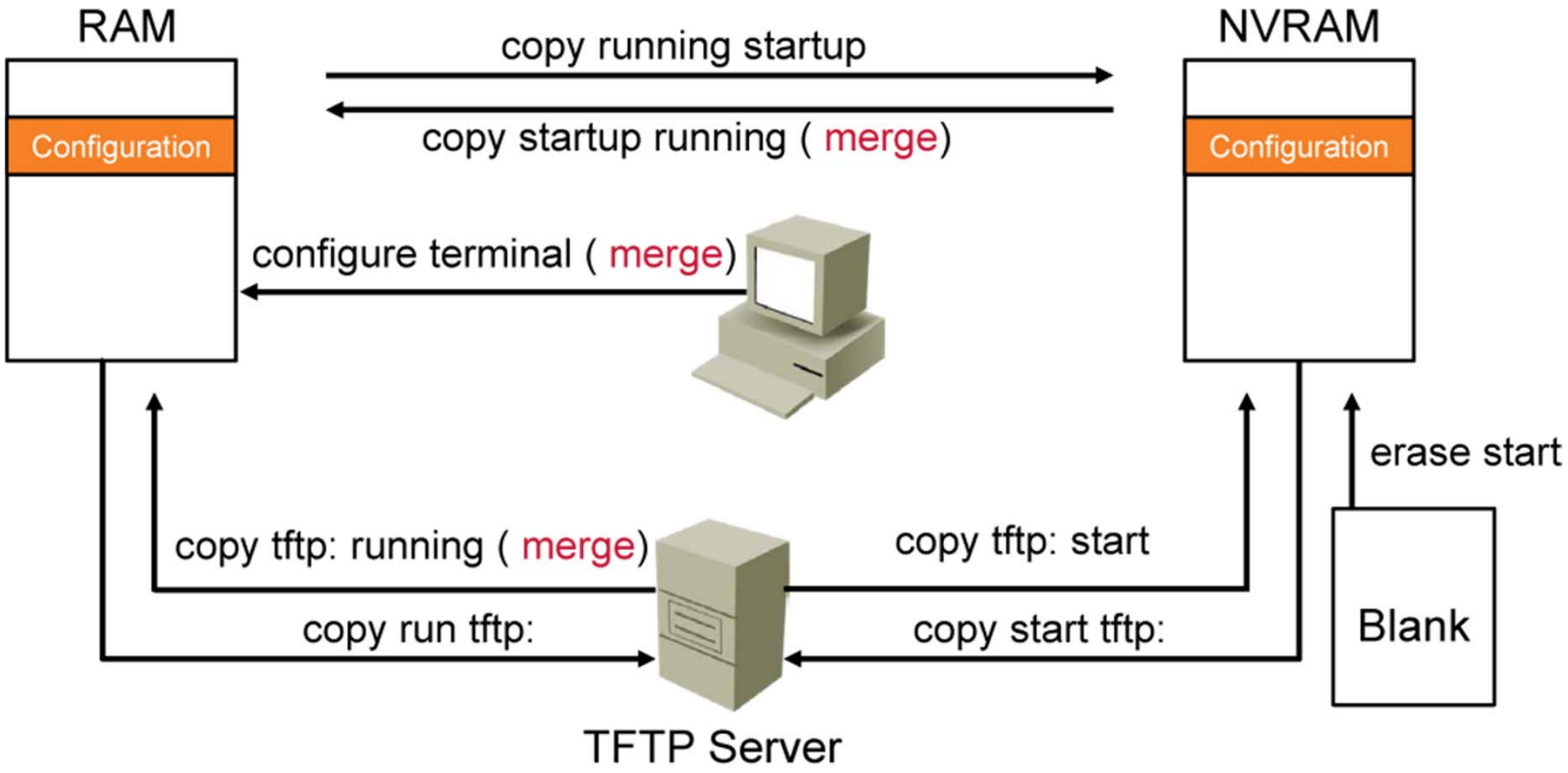
```
Switch#show startup-config
Using 1707 out of 65536 bytes
!
! Last configuration change at 04:45:43 UTC Fri Aug 17 2012
! NVRAM config last updated at 04:45:43 UTC Fri Aug 17 2012
!
version 15.0
no service pad
service timestamps debug datetime msec
<output omitted>
```

Managing Cisco IOS Configuration (Cont.)

A configuration can be backed up to an external server:



Managing Cisco IOS Configuration (Cont.)



Managing Cisco IOS Configuration (Cont.)

This is how you can save a device configuration:

```
Switch#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

This is how you back up a configuration to the TFTP server:

```
Switch#copy running-config tftp:
Address or name of remote host []? 10.1.1.1
Destination filename [running-config]? config.cfg
!!!
1684 bytes copied in 13.300 secs (129 bytes/sec)
```

Improving the User Experience in the CLI

Command-Line Editing Key Sequence	Description
Tab	Completes the remainder of the command or keyword
Ctrl-A	Moves the cursor to the beginning of the command line
Ctrl-E	Moves the cursor to the end of the command line
Backspace	Removes one character to the left of the cursor
Ctrl-U	Erases a line
Ctrl-Shift-6	Allows the user to abort a Cisco IOS process such as ping or traceroute
Ctrl-C	Aborts the current command and exits the configuration mode
Ctrl-Z	Ends configuration mode and returns to the EXEC prompt

Improving the User Experience in the CLI (Cont.)

```
Switch#terminal history size 50
```

- Sets session command buffer size to 50 lines

```
Switch#show history
  enable
  terminal history size 50
  show history
```

- Displays the contents of the command buffer

Improving the User Experience in the CLI (Cont.)

```
Switch#show running-config
Building configuration...

Current configuration : 1707 bytes
!
! Last configuration change at 11:46:10 UTC Fri Aug 17 2012
! NVRAM config last updated at 04:45:43 UTC Fri Aug 17 2012
!
<output omitted>
!
 --More--
```

- The Cisco IOS CLI pauses after a specific number of lines is displayed.

```
Switch#terminal length 100
```

- Sets the number of lines on the current terminal screen

Improving the User Experience in the CLI (Cont.)

You can filter **show** outputs using the pipe (|) character and a filtering parameter.

Use the **include** parameter to display configuration commands that include a specific word:

```
Switch#show running-config | include hostname
hostname Switch
```

Use the **section** parameter to display a section of the configuration:

```
Switch#show running-config | section FastEthernet0/11
interface FastEthernet0/11
 switchport access vlan 100
 switchport mode access
 switchport port-security
```

Summary

- Cisco IOS Software provides network services to Cisco products to perform various internetworking functions.
- The Cisco IOS CLI uses a hierarchy of commands in its command-mode structure.
- Two basic configuration modes are user EXEC mode and privileged EXEC mode.
- Context-sensitive help and console error messages are available in the Cisco IOS CLI to help you configure Cisco devices.
- Two general configurations that are used by Cisco routers and switches are the running configuration and the startup configuration.
- You can use hot keys and shortcuts, command history, and output filters to improve the CLI user experience.

Starting a Switch

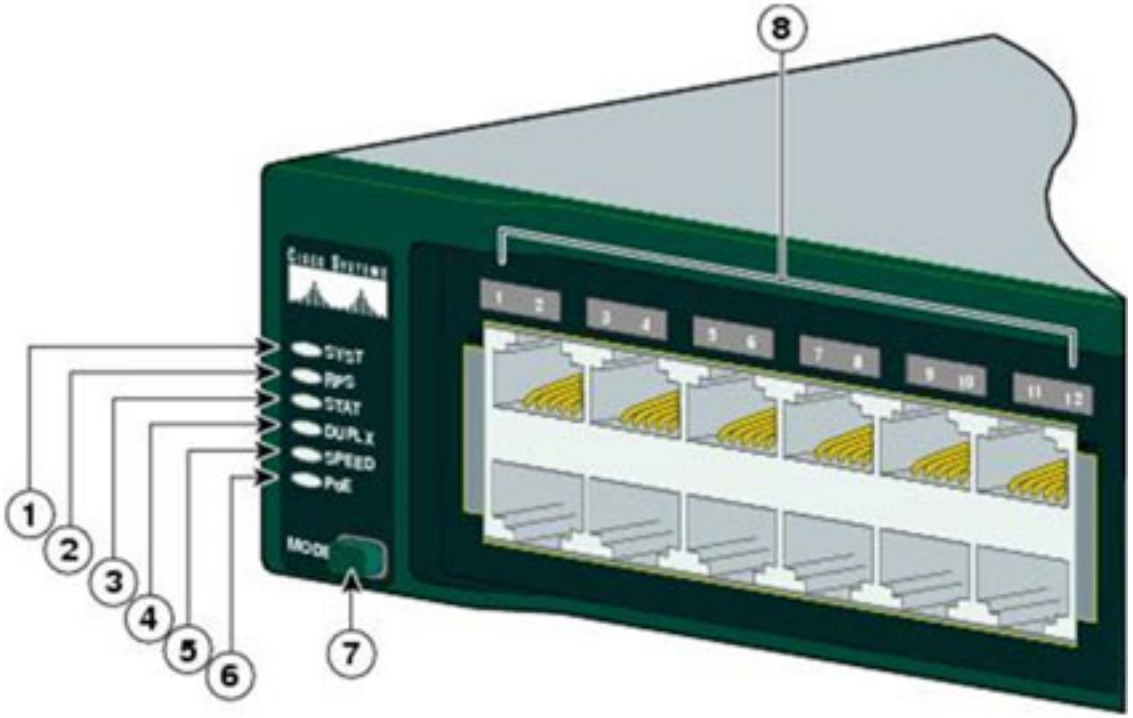
Building a Simple Network

Switch Installation

- Before installing a switch, verify the power and cooling requirements.
- Physically install the switch:
  - Rack mount
  - Wall mount
  - Table or shelf mount
- Verify the network cabling.
- Attach the power cable plug to start the switch.
- System startup routines perform POST and initiate the switch software.

Switch LED Indicators

- 1—System LED
- 2—Remote Power Supply LED
- 3–6—Port Mode LEDs
- 7—Mode Button
- 8—Port Status LED



Connecting to a Console Port

- Console port
- Console cable
- USB-to-serial port adapter

Basic Switch Configuration

Configuration modes:

- Global configuration mode

```
Switch#configure terminal
Switch(config)#
```

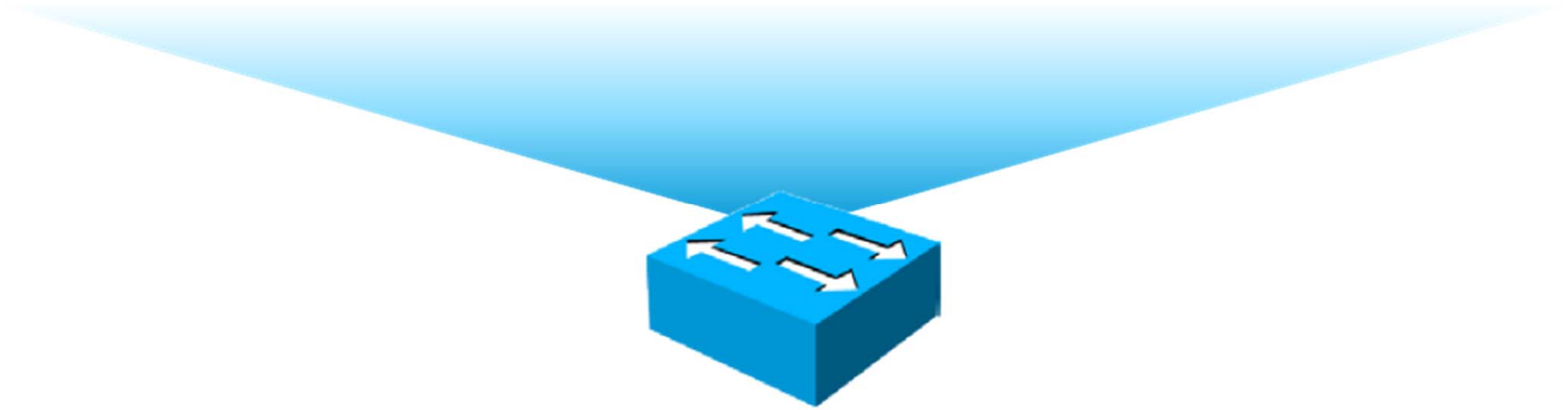
- Interface configuration mode

```
Switch(config)#interface FastEthernet0/1
Switch(config-if)#
```

Basic Switch Configuration (Cont.)

Set the local identity for the switch.

```
Switch(config)#hostname SwitchX
SwitchX(config)#
```



Basic Switch Configuration (Cont.)

Assign the IP address and subnet mask for the switch.

```
SwitchX(config)#interface vlan 1
SwitchX(config-if)#ip address 172.20.137.5 255.255.255.0
SwitchX(config-if)#no shutdown
```

Note: Most software versions require use of the **no shutdown** command to make the interface operational.

Verifying the Switch Initial Startup Status

```
SwitchX#show version
Cisco IOS Software, C2960 Software (C2960-LANBASEK9-M), Version 15.0(1)SE3,
RELEASE SOFTWARE (fc1)
<output omitted>
SwitchX uptime is 15 hours, 30 minutes
System returned to ROM by power-on
System restarted at 15:06:49 UTC Tue Aug 21 2012
System image file is "flash:/c2960-lanbasek9-mz.150-1.SE3/c2960-lanbasek9-
mz.150-1.SE3.bin"
<output omitted>
cisco WS-C2960-24TT-L (PowerPC405) processor (revision D0) with
65536K bytes of memory.
Processor board ID FOC1141Z8YW
<output omitted>
```

- Displays the configuration of the system hardware, software version, and boot images

Verifying the Switch Initial Startup Status (Cont.)

```
SwitchX#show interfaces FastEthernet 0/1
FastEthernet0/1 is up, line protocol is up (connected)
  Hardware is Fast Ethernet, address is 001e.147c.bd01 (bia 001e.147c.bd01)
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full-duplex, 100Mb/s, media type is 10/100BaseTX
<output omitted>
  5 minute input rate 31000 bits/sec, 33 packets/sec
  <output omitted>
 --More--
```

- Displays statistics for selected interfaces on the switch

Verifying the Switch Initial Startup Status (Cont.)

```
SwitchX#show running-config
Building configuration...
<output omitted>
!
hostname SwitchX
!
<output omitted>
!
interface Vlan1
 ip address 172.20.137.5 255.255.255.0
!
ip default-gateway 172.20.137.1
!
<output omitted>
```

- Displays the current active configuration file of the switch

Summary

- Physical switch installation must meet power and environmental requirements.
- Cisco IOS switches have several status LEDs that are generally green when the switch is functioning normally but turn amber when there is a malfunction.
- A console cable and port are needed to access the switch console and perform the initial configuration.
- Cisco IOS switches can be configured in the CLI using the global configuration mode and other configuration modes.
- You can verify switch hardware, software, and operational status using the **show version**, **show interfaces**, and **show running-config** commands.

Understanding Ethernet and Switch Operation

Building a Simple Network

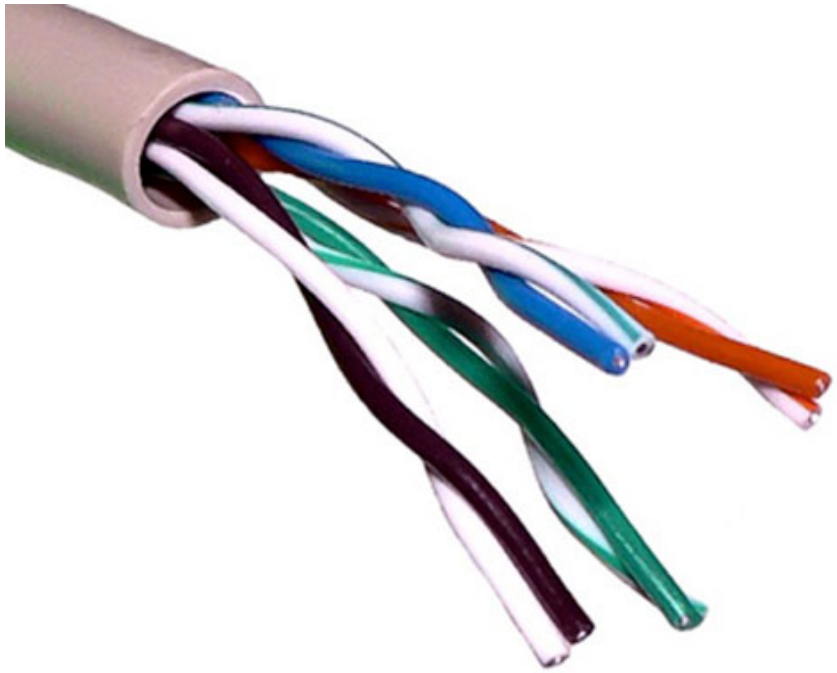
Ethernet LAN Connection Media

The mechanical properties of Ethernet depend on the type of physical medium:

- Coaxial (not used anymore)
- Copper
- Fiber-optic
- Ethernet was originally based on the concept of computers communicating over a shared coaxial cable, sharing files and applications.

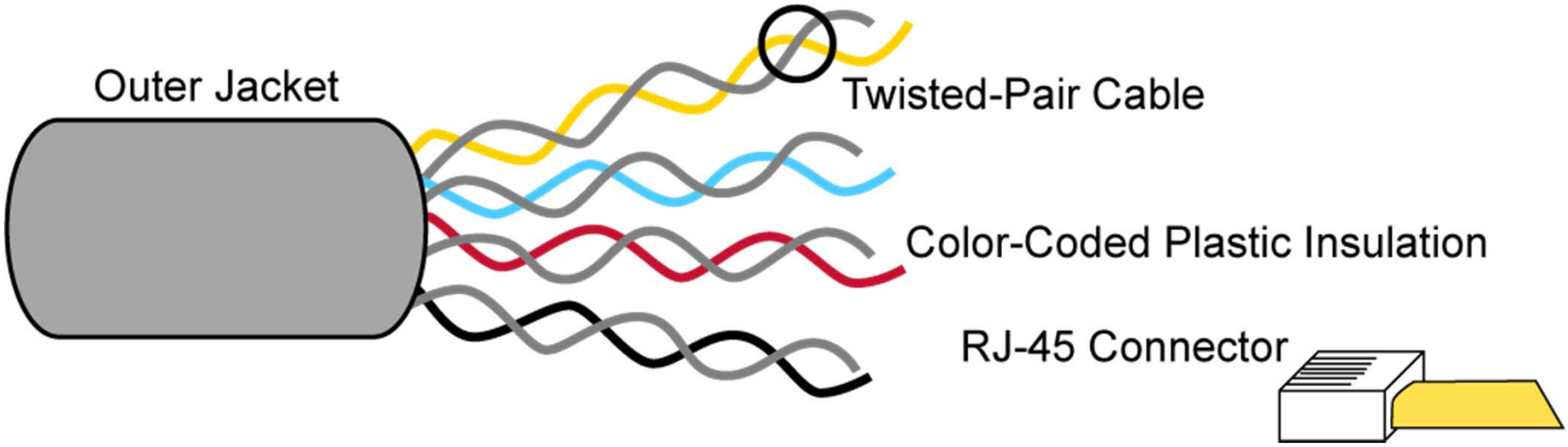
Ethernet LAN Connection Media (Cont.)

- Modifying Ethernet to conform to existing twisted-pair telephone wiring enabled cost reduction.
- UTP-based Ethernet, which uses copper, became widely deployed after the 10BASE-T standard.
- Fiber-optic variants of Ethernet offer high performance, electrical isolation, and long distance (tens of kilometers with some versions).



Ethernet LAN Connection Media (Cont.)

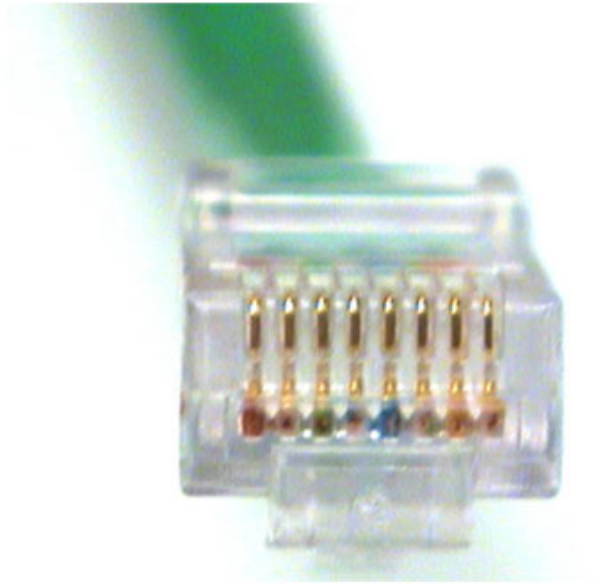
Unshielded Twisted-Pair Cable

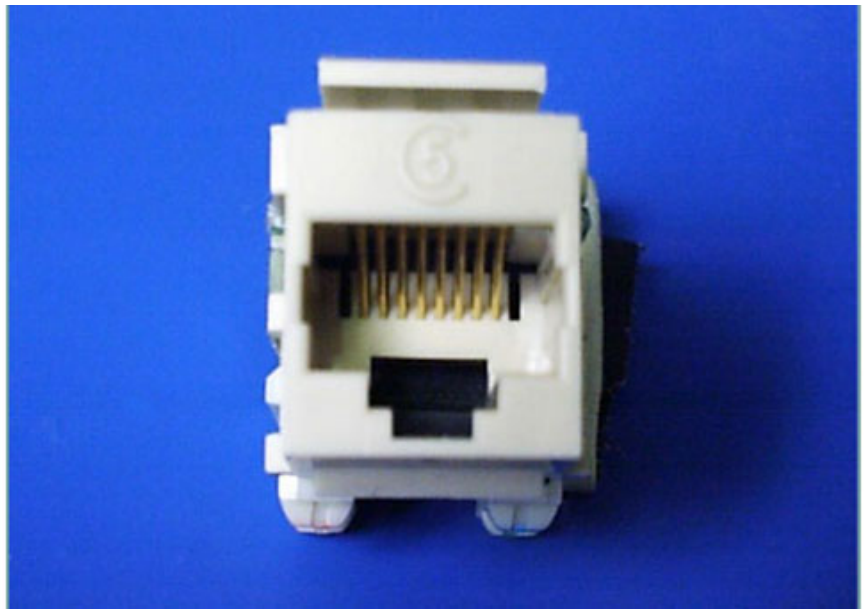


Characteristic	Value
Speed and throughput	From 10 Mb/s to 10 Gb/s
Average cost per node	Least expensive
Media and connector size	Small
Maximum cable length	Varies

Ethernet LAN Connection Media (Cont.)

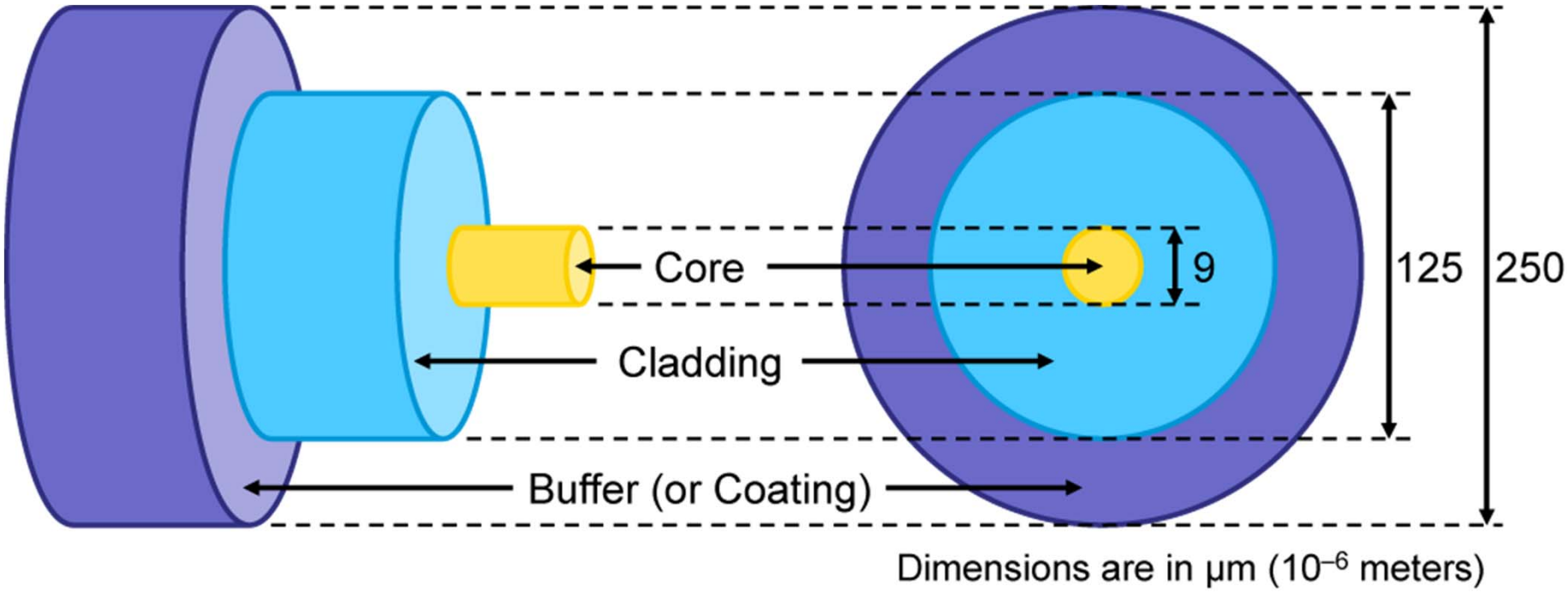
RJ-45 Connector and Jack





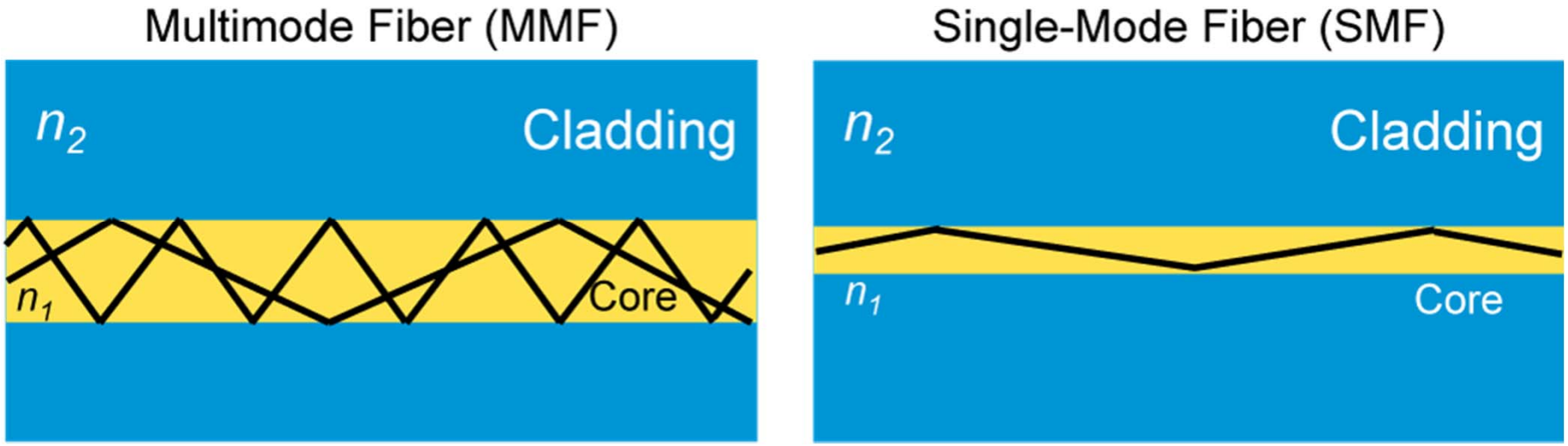
Ethernet LAN Connection Media (Cont.)

Optical Fiber (Single Mode)

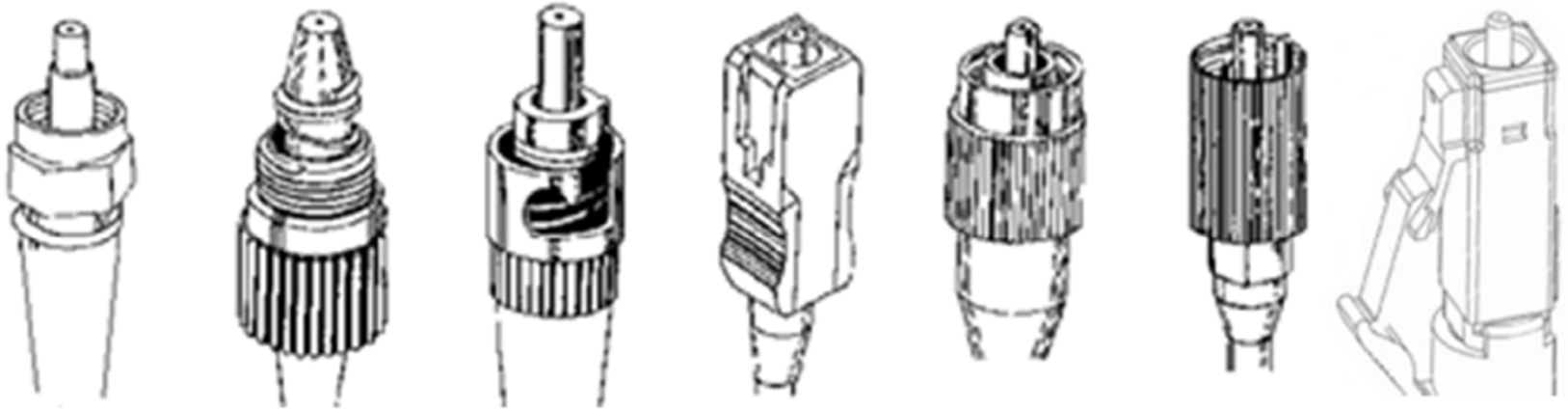


Ethernet LAN Connection Media (Cont.)

Fiber Types



Fiber Connector Types

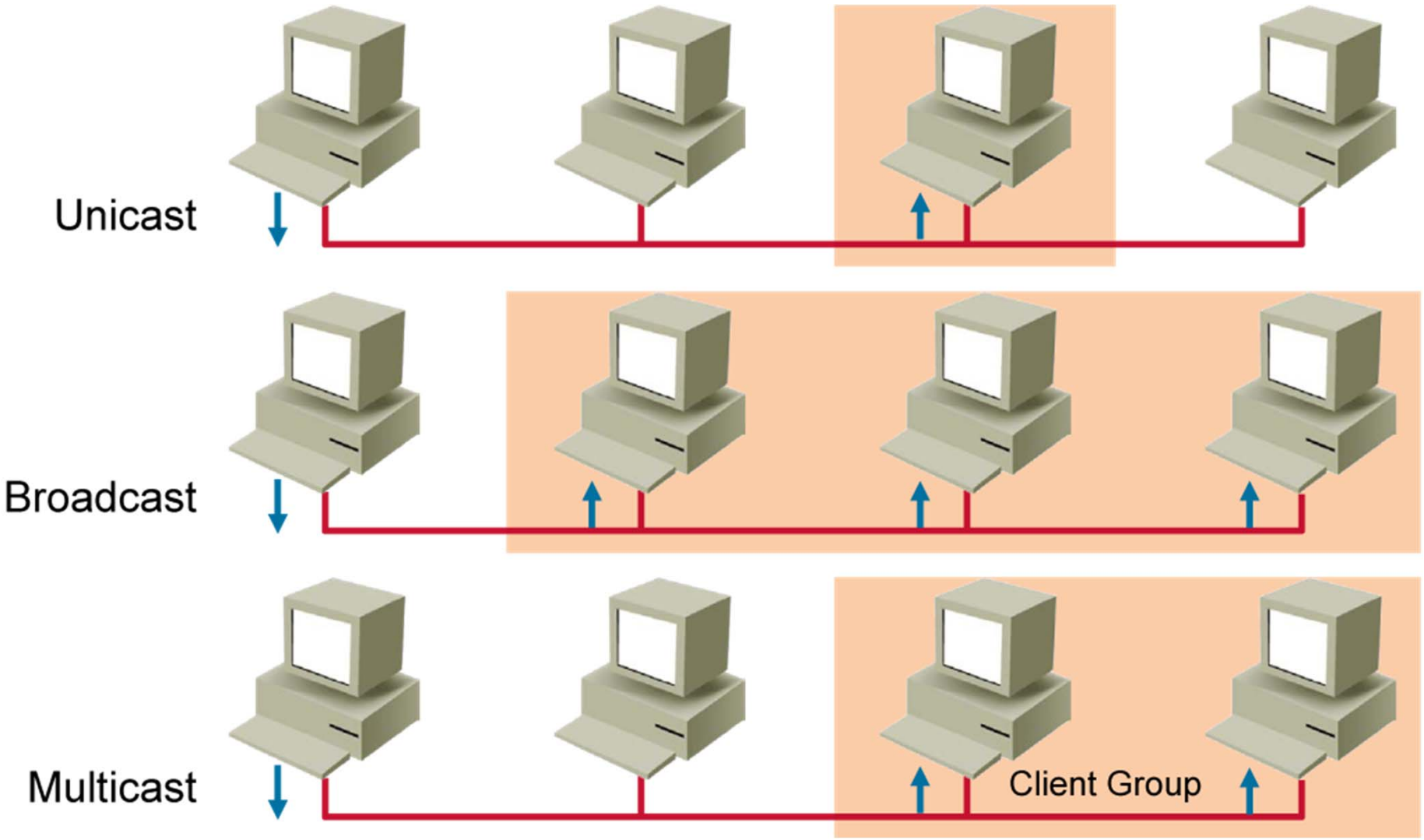


Ethernet Frame Structure

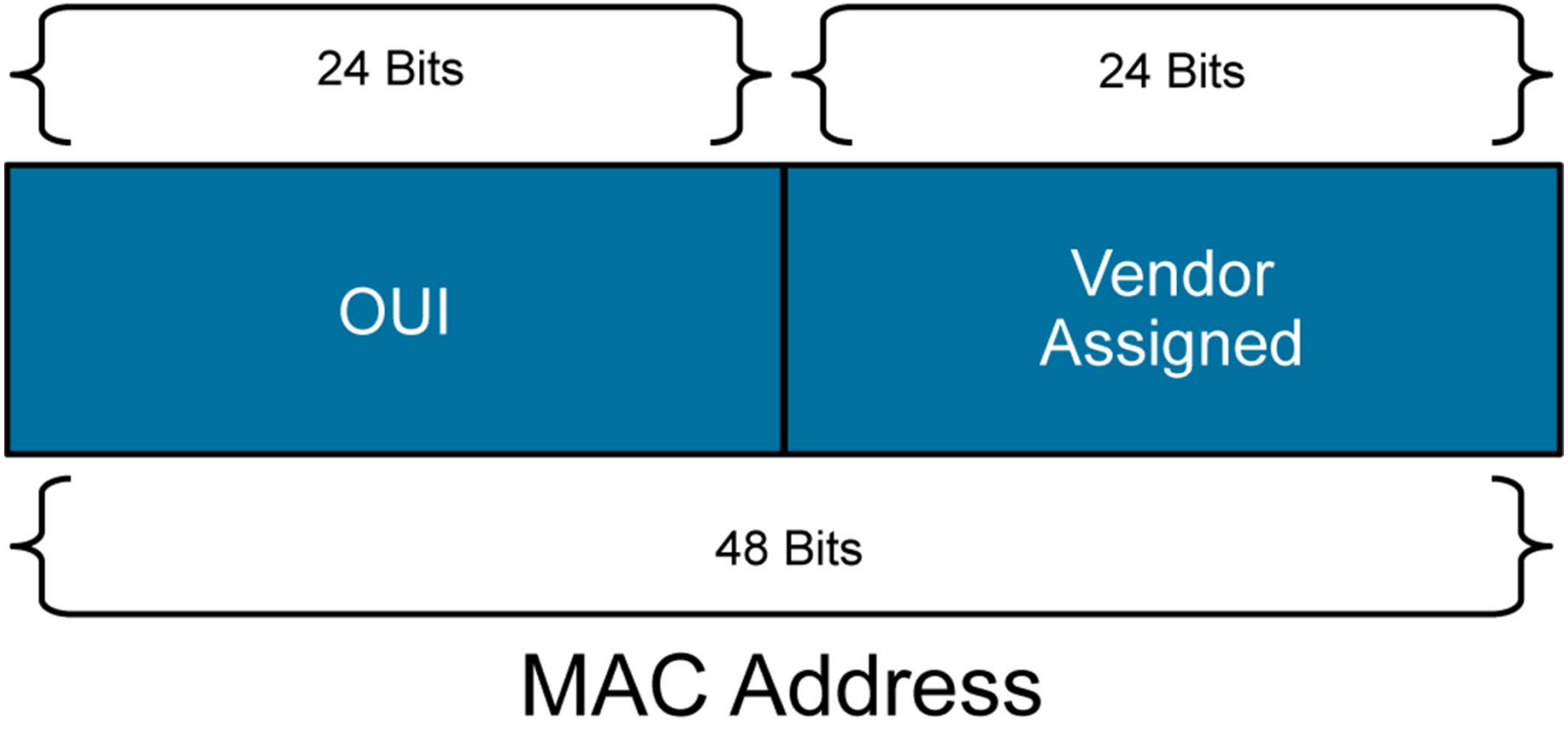
Typical Ethernet Frame					
8 bytes	6	6	2	46-1500	4
Preamble	Destination Address	Source Address	Type	Data	FCS

- FCS = frame check sequence
- Field length is stated in bytes.

MAC Addresses



MAC Addresses (Cont.)

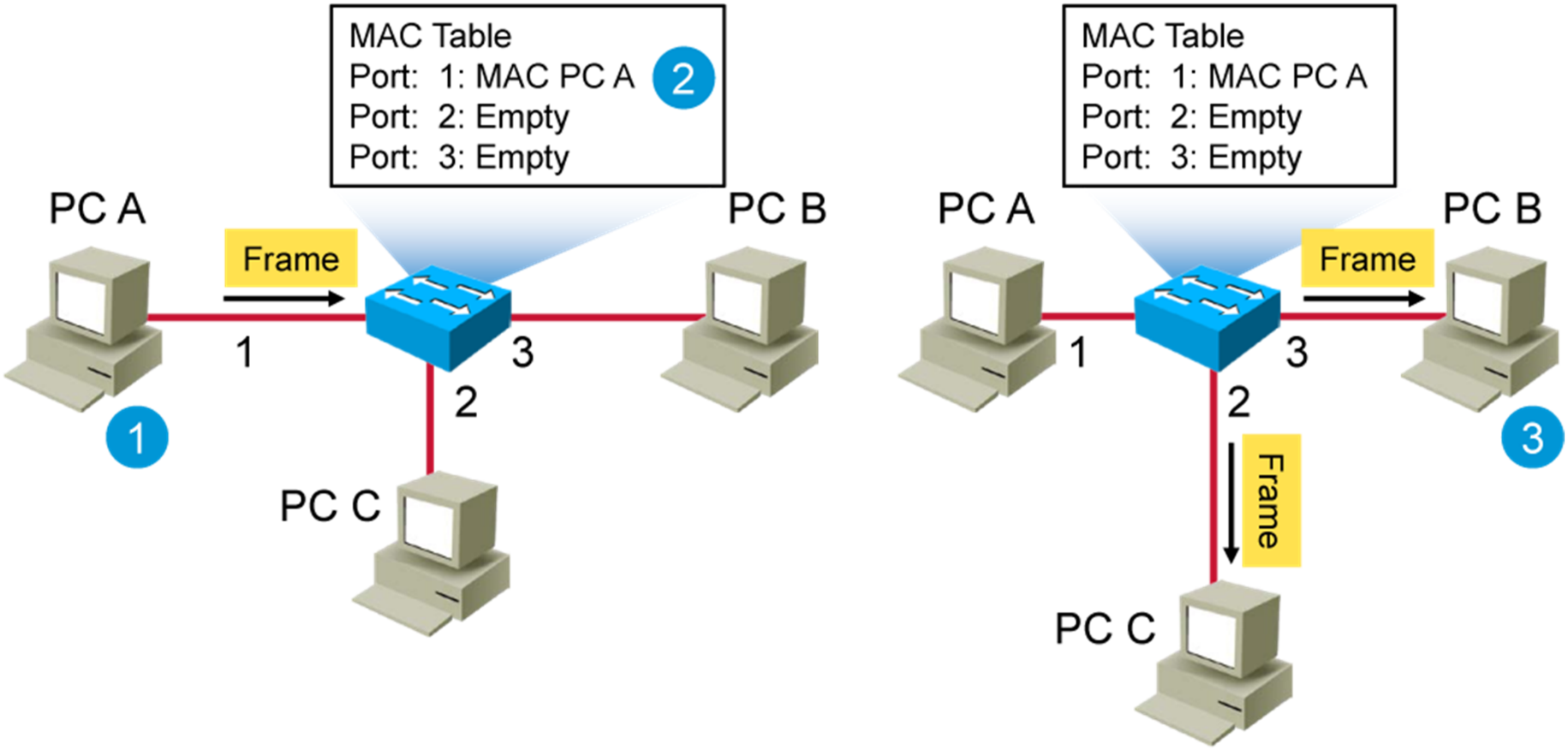


MAC Addresses (Cont.)

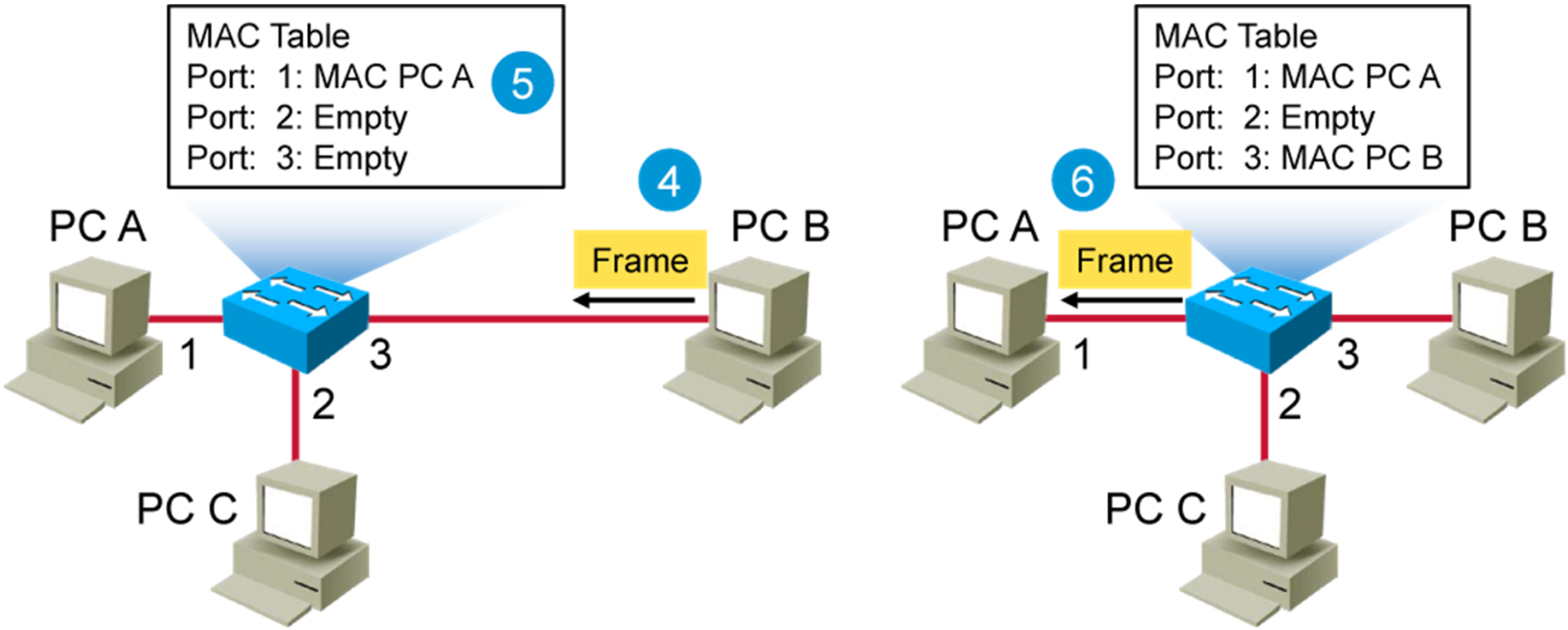
Different display formats:

- 0000.0c43.2e08
- 00:00:0c:43:2e:08
- 00-00-0C-43-2E-08

Switching Operation



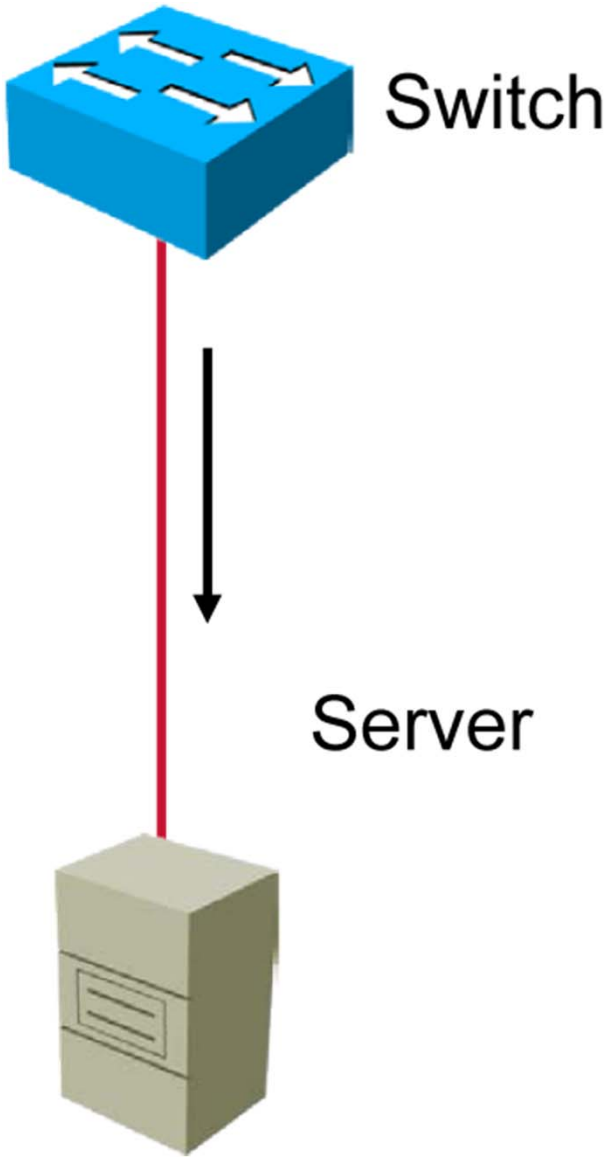
Switching Operation (Cont.)



Duplex Communication

Half-duplex operation:

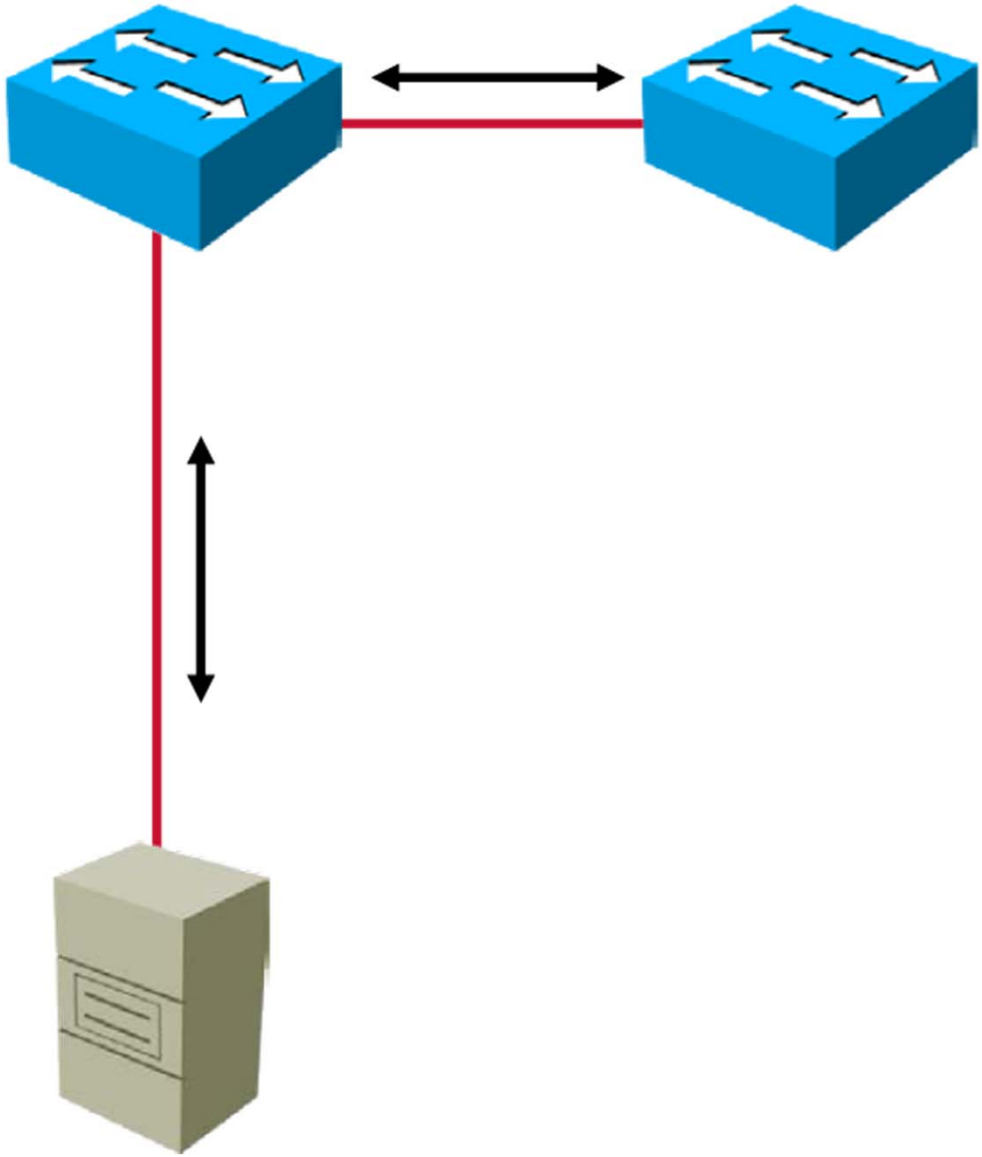
- Unidirectional data flow
- Higher potential for collision
- Legacy connectivity



Duplex Communication (Cont.)

Full-duplex operation:

- Point-to-point only
- Attached to dedicated switched port
- Requires full-duplex support on both ends



Configuring Duplex and Speed Options

- Setting full duplex and 100-Mb/s speed settings on the FastEthernet0/1
- Setting auto-duplex and auto-speed settings on the FastEthernet0/5


```
SwitchX(config)#interface FastEthernet0/1
SwitchX(config-if)#duplex full
SwitchX(config-if)#speed 100
SwitchX(config-if)#interface FastEthernet0/5
SwitchX(config-if)#duplex auto
SwitchX(config-if)#speed auto
```

General recommendation:

- Use manual settings on infrastructure links.
- Use auto settings on ports toward end devices.

Configuring Duplex and Speed Options (Cont.)

Overview of duplex settings and the resulting operation

Duplex settings	Half	Full	Auto
Half	Half	Mismatch	Half
Full	Mismatch	Full	Full
Auto	Half	Full	Full

Configuring Duplex and Speed Options (Cont.)

Verify the duplex and speed settings on the FastEthernet0/5 interface.

```
SwitchX#show interfaces FastEthernet0/5
FastEthernet0/5 is up, line protocol is up (connected)
  Hardware is Fast Ethernet, address is 0022.91c4.0e01 (bia 0022.91c4.0e01)
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full-duplex, 100Mb/s, media type is 10/100BaseTX
  input flow-control is off, output flow-control is unsupported
  <output omitted>
  5 minute input rate 0 bits/sec, 0 packets/secl
  5 minute output rate 0 bits/sec, 0 packets/sec
     7289 packets input, 927927 bytes, 0 no buffer
     Received 184 broadcasts (1380 multicasts
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog, 1380 multicast, 0 pause input
     0 input packets with dribble condition detected
     39965 packets output, 7985339 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier, 0 PAUSE output
     0 output buffer failures, 0 output buffers swapped out
```

Summary

- Ethernet over twisted-pair technologies use twisted-pair cables for the physical layer of an Ethernet computer network. Optical fiber permits transmission over longer distances and at higher data rates.
- The Ethernet frame contains header information, trailer information, and the actual data that is being transmitted.
- An Ethernet MAC address consists of two parts: OUI and a vendor-assigned end-station address.
- The switch creates and maintains a MAC address table by using the source MAC addresses of incoming frames and the port number through which the frame entered the switch.
- Full-duplex communication increases effective bandwidth by allowing both ends of the connection to transmit simultaneously.

Troubleshooting Common Switch Media Issues

Building a Simple Network

Common Troubleshooting Tools

ping command

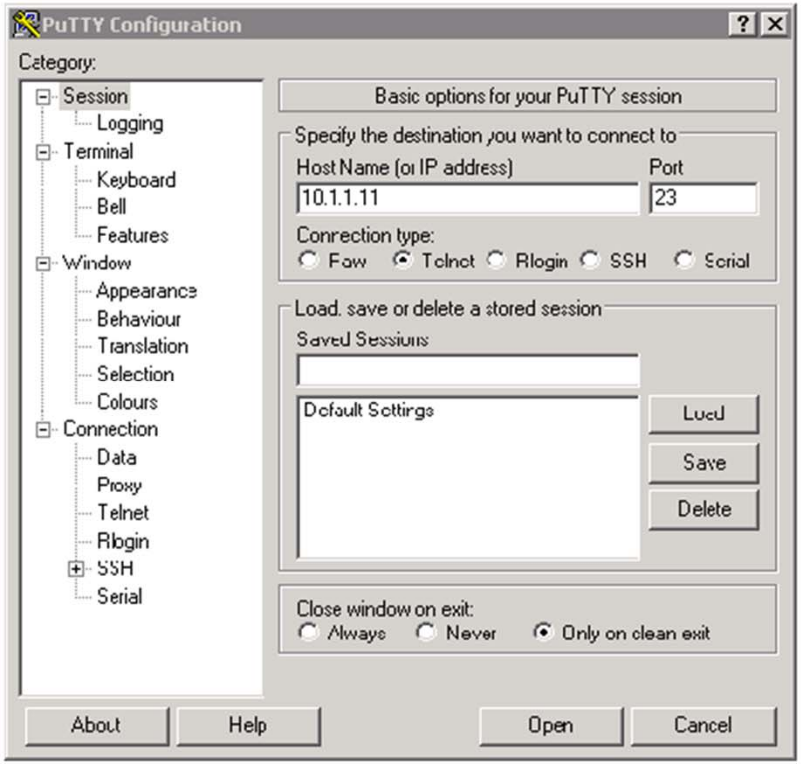
```
Switch#ping 10.1.1.100

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.100, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/203/1007 ms
```

```
C:\>ping example.com

Pinging example.com [192.0.43.10] with 32 bytes of data:
Reply from 192.0.43.10: bytes=32 time=107ms TTL=243
Reply from 192.0.43.10: bytes=32 time=107ms TTL=243
Reply from 192.0.43.10: bytes=32 time=137ms TTL=243
Reply from 192.0.43.10: bytes=32 time=107ms TTL=243

Ping statistics for 192.0.43.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 107ms, Maximum = 137ms, Average = 114ms
```

Common Troubleshooting Tools (Cont.)

Telnet

```
Switch1#telnet 10.1.20.1
Trying 10.1.20.1 ... Open

Switch2>
```



Media Issues – Copper

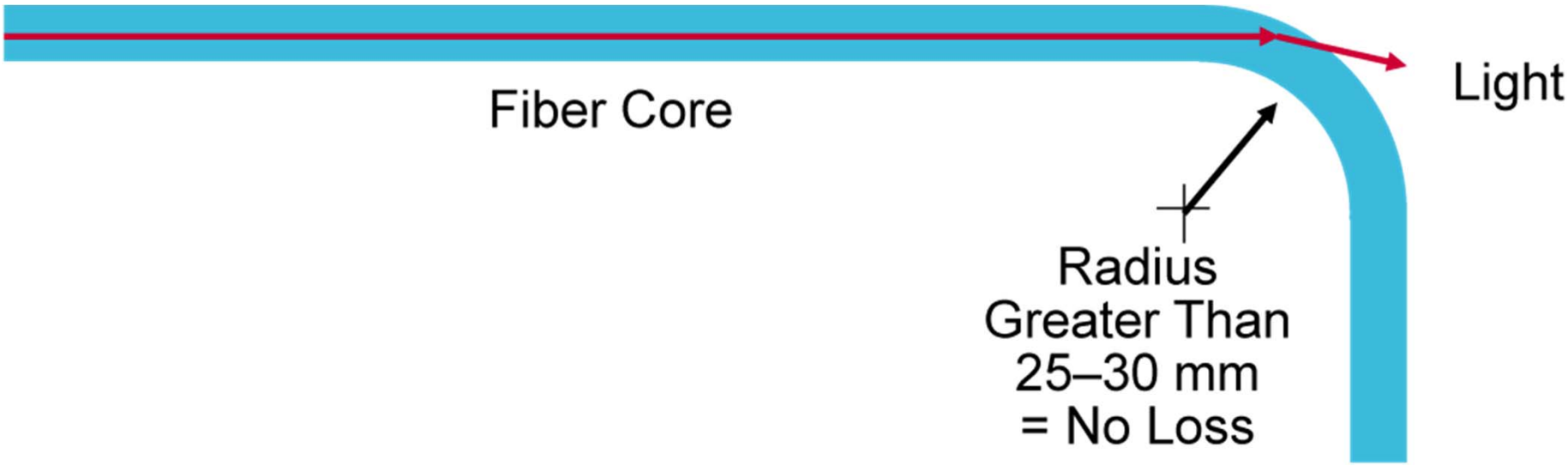
Copper media issues have several possible sources:

- Wiring becomes damaged.
- New EMI sources are introduced.
- Traffic patterns change.
- New equipment is installed.

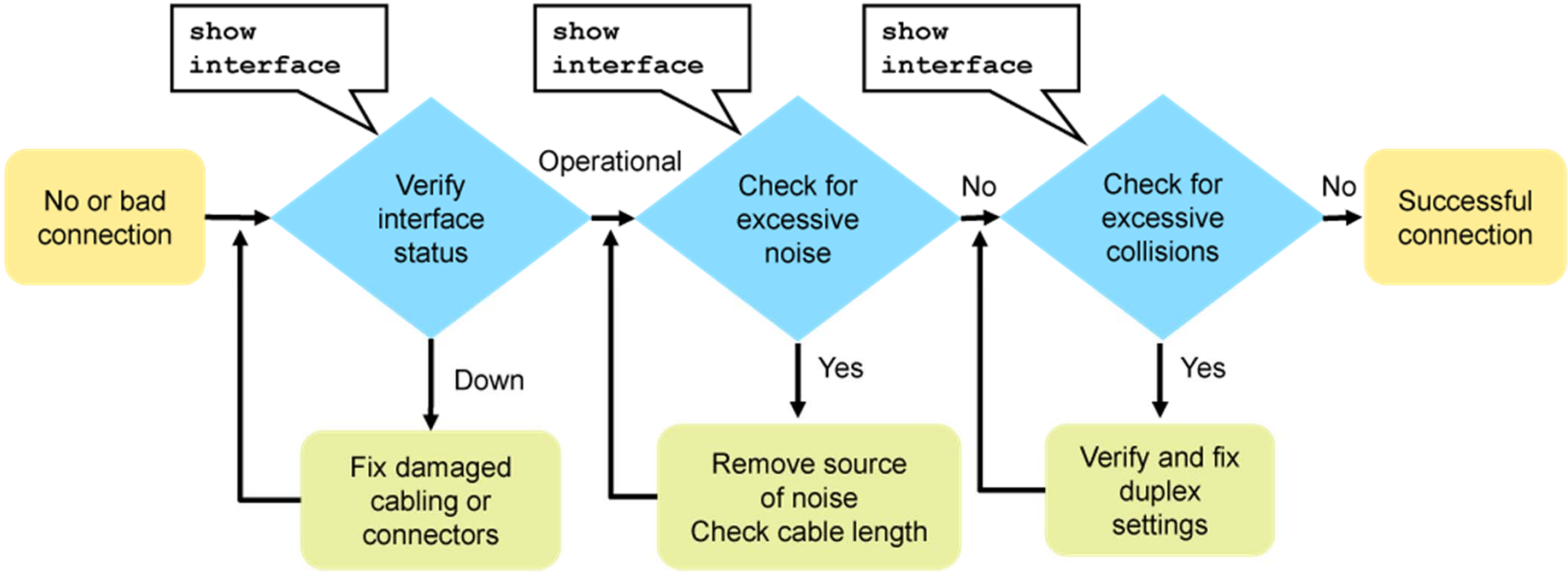
Media Issues – Fiber

Fiber media issues have these possible sources:

- Macrobend losses:
  - Bending the fiber in too small a radius causes light to escape.
  - Light strikes the core or cladding at less than the critical angle.
  - Total internal reflection no longer happens, and light leaks out.
- Splice losses



Troubleshooting Switch Media Issues



Troubleshooting Switch Media Issues (Cont.)

Verify interface status.

```
Switch#show interface FastEthernet0/1
FastEthernet0/1 is up, line protocol is up
Hardware is Fast Ethernet, address is 0022.91c4.0e01 (bia 0022.91c4.0e01)
MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
<output omitted>
```

Interface Status	Line Protocol Status	Link State
Up	Up	Operational
Up	Down	Connection problem
Down	Down (not connected)	Cable unplugged; other end of the link disconnected or interface in shutdown mode
Down	Down	Interface problem
Administratively down	Down	Disabled

Interface Status Verification

Excessive noise:

- Presence of many CRC errors
- Inspect the cable for damage and correct length, and search for noise sources

Excessive collisions:

- Normal in half-duplex operations
- Configure the link to use full-duplex

Excessive late collisions:

- Indicates duplex mismatch
- Configure both ends of the link to use the same duplex settings

Interface Status Verification (Cont.)

```
Switch#show interface FastEthernet0/1
FastEthernet0/1 is up, line protocol is up
Hardware is Fast Ethernet, address is 0022.91c4.0e01 (bia 0022.91c4.0e01)
MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
<output omitted> .
   2295197 packets input, 305539992 bytes, 0 no buffer
   Received 1925500 broadcasts, 0 runts, 0 giants, 0 throttles
   3 input errors, 3 CRC, 0 frame, 0 overrun, 0 ignored
   0 watchdog, 68 multicast, 0 pause input
   0 input packets with dribble condition detected
   3594664 packets output, 436549843 bytes, 0 underruns
   1935 output errors,1790 collisions,10 interface resets
   0 unknown protocol drops
   0 babbles, 135 late collision, 0 deferred
<output omitted>
```

- Displays interface status and statistics

Port Issues

Most common port issues are related to duplex and speed issues.

Duplex-related issues result from a mismatch in duplex settings:

Speed-related issues result from a mismatch in speed settings:

Port Issues (Cont.)

These are examples of duplex-related issues:

- One end set to full duplex and the other set to half duplex results in a mismatch.
- One end is set to full duplex and the other is set to autonegotiation:
  - If autonegotiation fails, and that end reverts to half duplex, it results in a mismatch.
- One end is set to half duplex and the other is set to autonegotiation:
  - If autonegotiation fails, and that end reverts to half duplex.
  - Both ends are set to half duplex, and there is no mismatch.

Port Issues (Cont.)

More examples of duplex-related issues:

- Autonegotiation is set on both ends:
  - One end fails to full duplex, and the other end fails to half duplex.
  - Example: A Gigabit Ethernet interface defaults to full duplex, while a 10/100 defaults to half duplex.
- Autonegotiation is set on both ends:
  - Autonegotiation fails on both ends, and they both revert to half duplex.
  - Both ends are set to half duplex, and there is no mismatch.

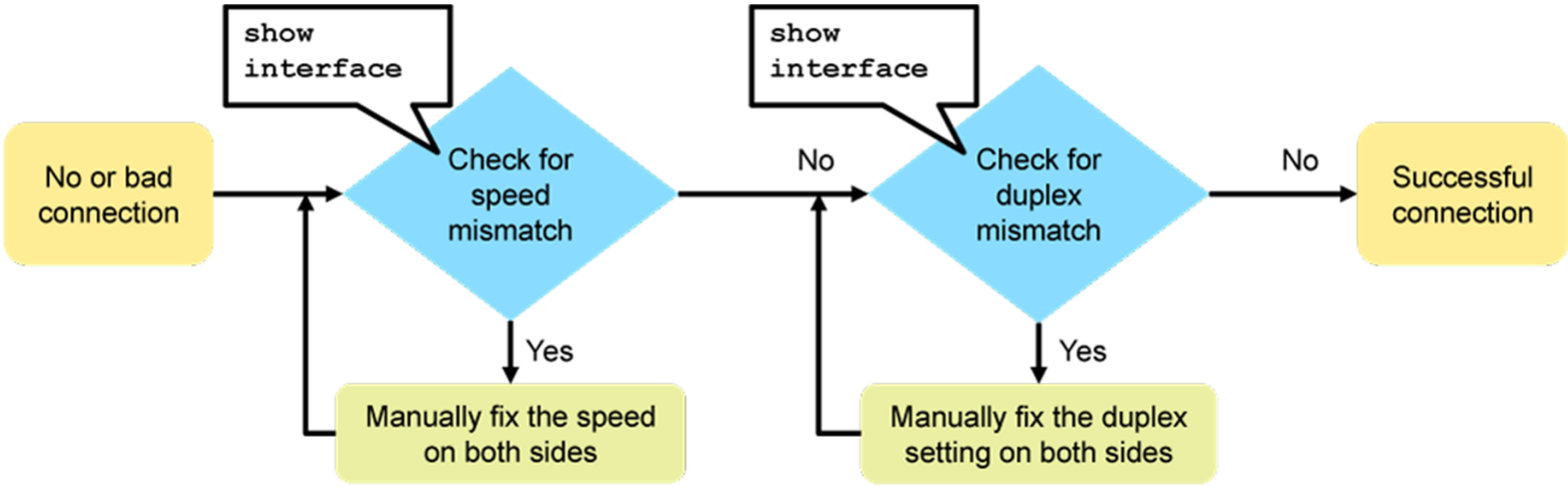
Port Issues (Cont.)

These are examples of speed-related issues:

- One end is set to one speed and the other is set to another speed, resulting in a mismatch.
- One end is set to a higher speed and autonegotiation is enabled on the other end:
  - If autonegotiation fails, switch senses what the other end is using and reverts to optimal speed.
- Autonegotiation is set on both ends:
  - Autonegotiation fails on both ends, and they revert to their lowest speed.
  - Both ends are set at lowest speed, and there is no mismatch.

Troubleshooting Port Issues

Troubleshooting duplex-related issues:




```
%CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on FastEthernet0/1 (not
half duplex)
```

- Duplex mismatch detected by Cisco Discovery Protocol

Troubleshooting Port Issues (Cont.)

```
Switch#show interfaces FastEthernet 0/1
FastEthernet0/1 is up, line protocol is up (connected)
  Hardware is Fast Ethernet, address is 001e.147c.6f01 (bia 001e.147c.6f01)
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full-duplex, 100Mb/s, media type is 10/100BaseTX
  input flow-control is off, output flow-control is unsupported
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:28, output 00:00:01, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
```

- Displays duplex and speed statistics

Summary

- Use **ping** and **telnet** commands to verify connectivity.
- Switch media issues are common and have several possible sources, such as damaged copper wiring, EMI, and macrobend and splice losses in fiber media.
- Speed or duplex mismatch on a link leads to serious performance degradation.
- Use the **show interface** verification command when troubleshooting speed and duplex port issues.

Module Summary

- A network is a connected collection of devices (computers, interconnections, routers, and switches) that can communicate with each other, providing the means for users to share hardware and applications.
- TCP/IP defines four categories of functions that must occur for communications to be successful (the network access, Internet, transport, and application layers).
- A LAN is a network that is located in a limited area, with the computers and other components that are part of this network located relatively close together.
- Ethernet switches divide collision domains and reduce the number of devices that are competing for bandwidth. Ethernet switches selectively forward individual frames from a receiving port to the destination port.

Module Summary (Cont.)

- Cisco IOS Software provides network services to Cisco products to perform various internetworking functions.
- Ethernet over twisted-pair technologies use twisted-pair cables for the physical layer of an Ethernet computer network. Optical fibers permit transmission over longer distances and at higher data rates.
- The switch creates and maintains a MAC address table by using the source MAC addresses of incoming frames and the port number through which the frame entered the switch.
- Switch media issues are common and have several possible sources, such as damaged copper wiring, EMI sources, and macrobend and splice losses in fiber media.
- Speed or duplex mismatch on a link leads to serious performance degradation.