



## Chapter 8: Networks



### IT Essentials: PC Hardware and Software v4.0

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Mind Wide Open™

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Chapter 8

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## Principles of Networking

- Networks are systems that are formed by links.
- People use different types of networks every day:

Mail delivery system

Telephone system

Public transportation system

Corporate computer network

The Internet



- Computers can be linked by networks to share data and resources.
- A network can be as simple as two computers connected by a single cable or as complex as hundreds of computers connected to devices that control the flow of information.

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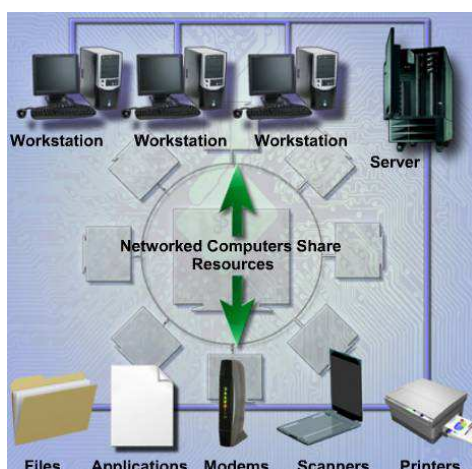
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## Computer Networks

- Network devices include:
  - Desktop and laptop computers
  - Printers and scanners
  - PDA's and Smartphones
  - File and print servers
- Resources shared across networks include:
  - Services, such as printing or scanning
  - Storage devices, such as hard drives or optical drives
  - Applications, such as databases
- Different types of network media:
  - Copper cabling
  - Fiber-optic cabling
  - Wireless connection



## Benefits of Networking



- Fewer peripherals needed
- Increased communication capabilities
- Avoid file duplication and corruption
- Lower cost licensing
- Centralized administration
- Conserve resources

## Local Area Network (LAN)



- A group of interconnected computers that is under the same administrative control.
- Can be as small as a single local network installed in a home or small office.
- Can consist of interconnected local networks consisting of many hundreds of hosts, installed in multiple buildings and locations.

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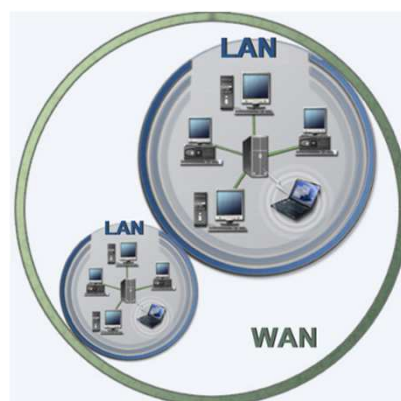
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## Wide Area Network (WAN)

- A WAN connects LANs in geographically separated locations.
  - A WAN covers a much larger area than a LAN.
- The Internet is a large WAN.
- Telecommunications service providers (TSP) are used to interconnect these LANs at different locations.



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## Wireless LAN (WLAN)

- **Wireless** devices are used to transmit and receive data using radio waves.
- Wireless devices connect to **access points** within a specified area.
- Access points connect to the network using copper cabling.
- WLAN coverage can be limited to the area of a room, or can have greater range.
- You can share resources such as files and printers, and access the Internet on a WLAN.


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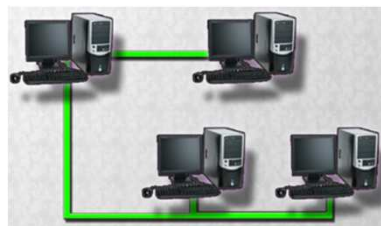
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## Peer-to-Peer Networking

- Share files, send messages, and print to a shared printer.
- Each computer has similar capabilities and responsibilities.
- Each user decides which data and devices to share.
- No central point of control in the network.
- Best if there are ten or fewer computers.


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## Disadvantages of Peer-to-Peer

- Without centralized network administration, it is difficult to determine who controls network resources.
- Without centralized security, each computer must use separate security measures for data protection.
- More complex and difficult to manage as the number of computers on the network increases.
- Without centralized data storage, data backups must be performed by users.

## Client/Server Network

- Client/server network model provides security and control for the network.
- Client requests information or services from the server.
- Server provides the requested information or service.
- Servers are maintained by network administrators.
  - Data backups and security measures
  - Control of user access to network resources
- Centralized storage and services include:
  - Data stored on a centralized file server
  - Shared printers managed by a print server
  - Users have proper permissions to access data or printers



## Networking Concepts and Technologies

- A computer technician is required to configure and troubleshoot computers on a network.
- A computer technician should understand IP addressing, protocols, and other network concepts.



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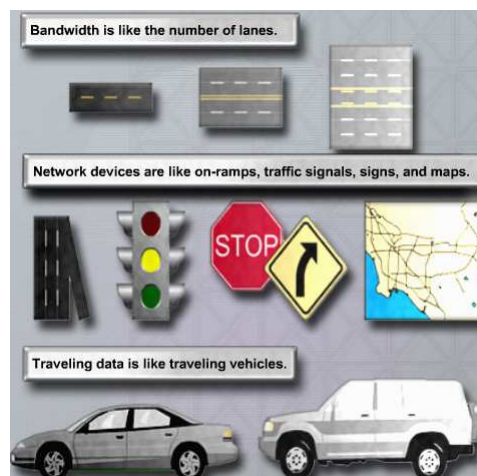
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## Bandwidth

- amount of data that can be transmitted within a fixed time period
- measured in bits per second and is usually denoted by the following:
  - bps - bits per second
  - Kbps - kilobits per second
  - Mbps - megabits per second



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## Three Modes of Transmission

Data is transmitted in one of three modes:

1. **Simplex** (Unidirectional transmission) is a single, one-way transmission.  
Example: The signal sent from a TV station to your TV.
2. **Half-duplex** allows data to flow in one direction at a time.  
Simultaneous transmission in two directions is not allowed.  
Example: Two-way radios, police or emergency mobile radios
3. **Full-duplex** allows data to flow in both directions at the same time.  
Bandwidth is measured in only one direction. 100 Mbps full-duplex means a bandwidth of 100 Mbps in each direction.  
Broadband technologies, such as digital subscriber line (DSL) and cable, operate in full-duplex mode.

## IP Address

- An IP address is a unique number that is used to identify a network device.
- An IP address is represented as a 32-bit binary number, divided into four **octets** (groups of eight bits):  
Example: 10111110.01100100.00000101.00110110
- An IP address is also represented in a **dotted decimal** format.  
Example: 190.100.5.54
- When a host is configured with an IP address, it is entered as a dotted decimal number, such as 192.168.1.5.
- Unique IP addresses on a network ensure that data can be sent to and received from the correct network device.

## IP Address Classes

- **Class A**  
Large networks, implemented by large companies and some countries
- **Class B**  
Medium-sized networks, implemented by universities
- **Class C**  
Small networks, implemented by ISP for customer subscriptions
- **Class D**  
Special use for multicasting
- **Class E**  
Used for experimental testing

## Subnet Masks

- Used to indicate the network portion of an IP address
- Is a dotted decimal number
- Usually, all hosts within a broadcast domain of a LAN (bounded by routers) use the same subnet mask.
- The default subnet masks for three classes of IP addresses:
  - 255.0.0.0 is the subnet mask for Class A
  - 255.255.0.0 is the subnet mask for Class B
  - 255.255.255.0 is the subnet mask for Class C
- If an organization owns one Class B network but needs to provide IP addresses for four LANs, the organization will subdivide the Class B network into four smaller parts by using subnetting, which is a logical division of a network. The subnet mask specifies how it is subdivided.



## IP Address Configuration

- Manual configuration

Manually configure each device with the proper IP address and subnet mask.

- Dynamic configuration

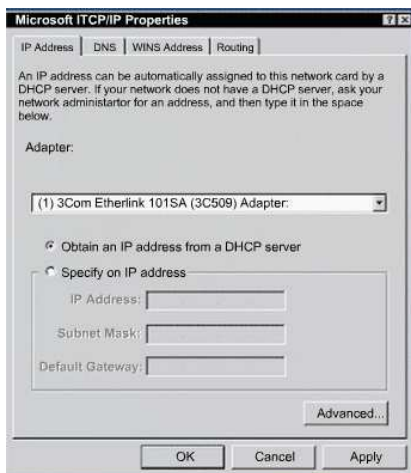
A Dynamic Host Configuration Protocol (DHCP) server automatically assigns IP addresses to network hosts.

- Network Interface Card (NIC) is the hardware that enables a computer to connect to a network and it has two addresses:

The IP address is a logical address that can be changed.

The **Media Access Control (MAC) address** is "burned-in" or permanently programmed into the NIC when manufactured. The MAC address cannot be changed.

## Dynamic Host Configuration Protocol (DHCP)



- DHCP** automatically provides computers with an IP address.

- The DHCP server can assign these to hosts:

IP address

Subnet mask

Default gateway

Domain Name System (DNS) server address

## DHCP Process and Advantages

DHCP process:

1. DHCP server receives a request from a host.
2. Server selects IP address information from a database.
3. Server offers the addresses to requesting host.
4. If the host accepts the offer, the server leases the IP address for a specific period of time.

Advantages of DHCP:

- Simplifies the administration of a network
- Reduces the possibility of assigning duplicate or invalid addresses

## Configure Host to Use DHCP

Configure the host to "Obtain an IP address automatically" in the TCP/IP properties of the NIC configuration window



## Internet Protocols

- A **protocol** is a set of rules.
- Internet protocols are sets of rules governing communication within and between computers on a network.
- Many protocols consist of a **suite** (or group) of protocols stacked in layers. These layers depend on the operation of the other layers in the suite to function properly.
- The main functions of protocols:
  - Identifying errors
  - Compressing the data
  - Deciding how data is to be sent
  - Addressing data
  - Deciding how to announce sent and received data

## Common Network Protocols

Protocols used for browsing the web, sending and receiving e-mail, and transferring data files

	Description
<b>TCP/IP</b>	A protocol used to transport data on the Internet.
<b>NETBEUI NETBIOS</b>	A small, fast protocol designed for a workgroup network that requires no connection to the Internet.
<b>IPX and SPX</b>	A protocol used to transport data on a Novell Netware network.
<b>HTTP and HTTPS</b>	A protocol that defines how files are exchanged on the Web.
<b>FTP</b>	A protocol that provides services for file transfer and manipulation.
<b>SSH</b>	A protocol that is used to connect computers together securely.
<b>Telnet</b>	A protocol that uses a text-based connection to a remote computer.
<b>POP</b>	A protocol used to download email messages from an email server.
<b>IMAP</b>	A protocol used to download email messages from an email server.
<b>SMTP</b>	A protocol used to send mail in a TCP/IP network.

## Internet Control Message Protocol (ICMP)

- **Internet Control Message Protocol (ICMP)** is used by devices on a network to send control and error messages to computers and servers.
- **PING (Packet Internet Groper)** is a simple command line utility used to test connections between computers
  - Used to determine whether a specific IP address is accessible.
  - Used with either the hostname or the IP address.
  - Works by sending an ICMP echo request to a destination computer.
  - Receiving device sends back an ICMP echo reply message.

## Ping Command Switches

```

C:\WINDOWS\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\>ping /?

Usage: ping [-t] [-a] [-n count] [-l size] [-f] [-i TTL] [-v TOS]
           [-r count] [-s count] [[-j host-list] ! [-k host-list]]
           [-w timeout] target_name

Options:
-t           Ping the specified host until stopped.
             To see statistics and continue - type Control-Break;
             To stop - type Control-C.
-a           Resolve addresses to hostnames.
-n count    Number of echo requests to send.
-l size     Send buffer size.
-f          Set Don't Fragment flag in packet.
-i TTL      Time To Live.
-v TOS      Type Of Service.
-r count    Record route for count hops.
-s count    Timestamp for count hops.
-j host-list Loose source route along host-list.
-k host-list Strict source route along host-list.
-w timeout  Timeout in milliseconds to wait for each reply.
  
```

These command line **switches** (options) can be used with the ping command.

## Output of the Ping Command

- Four ICMP echo requests (pings) are sent to the destination computer to determine the reliability and reachability of the destination computer.

```

C:\WINDOWS\system32\cmd.exe
C:\>ping 192.168.1.1

Pinging 192.168.1.1 with 32 bytes of data:

Reply from 192.168.1.1: bytes=32 time<1ms TTL=150
Reply from 192.168.1.1: bytes=32 time<1ms TTL=150
Reply from 192.168.1.1: bytes=32 time<1ms TTL=150
Reply from 192.168.1.1: bytes=32 time<1ms TTL=150

Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping cisco.com

Pinging cisco.com [198.133.219.25] with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 198.133.219.25:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

```

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## Physical Network Components

- Network devices:
  - Computers
  - Hubs
  - Switches
  - Routers
  - Wireless access points
- Network media:
  - Twisted-pair copper cabling
  - Fiber-optic cabling
  - Radio waves


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## Hubs



- Extend the range of a signal by receiving then regenerating it and sending it out all other ports
- Traffic is sent out all ports of the hub
- Allow a lot of **collisions** on the network segment and are often not a good solution
- Also called **concentrators** because they serve as a central connection point for a LAN

## Bridges and Switches

- A packet, along with its MAC address information, is called a **frame**.
- LANs are often divided into sections called **segments** bounded by bridges.
- A **bridge** has the intelligence to determine if an incoming frame is to be sent to a different segment, or dropped. A bridge has two ports.
- A **switch** (multiport bridge) has several ports and refers to a table of MAC addresses to determine which port to use to forward the frame.





## Routers



- **Routers** are devices that connect entire networks to each other.

Use IP addresses to forward packets to other networks.

Can be a computer with special network software installed.

Can be a device built by network equipment manufacturers.

Contain tables of IP addresses along with optimal routes to other networks.

## Wireless Access Points



- Provide network access to wireless devices such as laptops and PDAs.
- Use radio waves to communicate with radios in computers, PDAs, and other wireless access points.
- Have limited range of coverage.

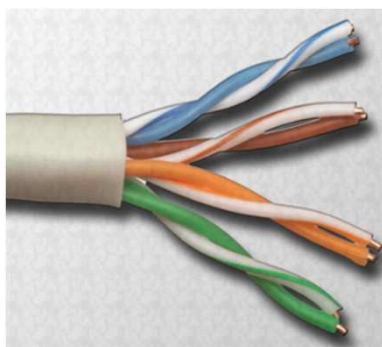
## Multipurpose Devices

- Perform more than one function.
- More convenient to purchase and configure just one device.
- Combines the functions of a switch, a router and a wireless access point into one device.
- The Linksys 300N is an example of a multipurpose device.



## Twisted-Pair Cabling

- A pair of twisted wires forms a circuit that transmits data.
- The twisted wires provide protection against **crosstalk** (electrical noise) because of the **cancellation effect**.



Pairs of copper wires are encased in color-coded plastic insulation and twisted together.

An outer jacket, called poly-vinyl chloride (PVC), protects the bundles of twisted pairs.

## Two Basic Types of Twisted-Pair Cables

- **Unshielded twisted-pair (UTP)**

Has two or four pairs of wires

Relies on the cancellation effect for reduction of interference caused by electromagnetic interface (EMI) and radio frequency interference (RFI)

Most commonly used cabling in networks

Has a range of 328 ft (100 meters)

- **Shielded twisted-pair (STP)**

Each pair is wrapped in metallic foil to better shield the wires from electrical noise and then the four pairs of wires are then wrapped in an overall metallic braid or foil.

Reduces electrical noise from within the cable.

Reduces EMI and RFI from outside the cable.

## Category Rating

- UTP comes in several categories that are based on two factors:

The number of wires in the cable

The number of twists in those wires

- Category 3 is used for telephone connections.
- Category 5 and Category 5e have are the most common network cables used.
- Category 6 cable has higher data rate than the Cat 5 cables.

## Coaxial Cable

- A copper-cored network cable surrounded by a heavy shielding



- Types of coaxial cable:

**Thicknet or 10Base5** - Coax cable that was used in networks and operated at 10 megabits per second with a maximum length of 500 m

**Thinnet or 10Base2** - Coax cable that was used in networks and operated at 10 megabits per second with a maximum length of 185 m

**RG-59** - Most commonly used for cable television in the US

**RG-6** - Higher quality cable than RG-59 with more bandwidth and less susceptibility to interference

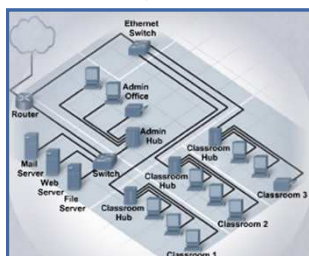
## Fiber-Optic Cable



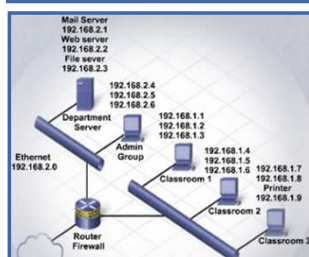
- A glass or plastic strand that transmits information using light and is made up of one or more optical fibers enclosed together in a sheath or jacket.
- Not affected by electromagnetic or radio frequency interference.
- Signals are clearer, can go farther, and have greater bandwidth than with copper cable.
- Usually more expensive than copper cabling and the connectors are more costly and harder to assemble.
- Two types of glass fiber-optic cable:

**Multimode** and **Single-mode**

## Two Types of LAN Topologies



**Physical topology** is the physical layout of the components on the network

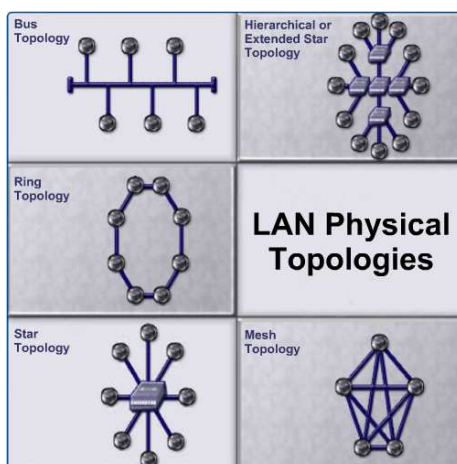


**Logical topology** determines how the hosts access the medium to communicate across the network

## LAN Physical Topologies

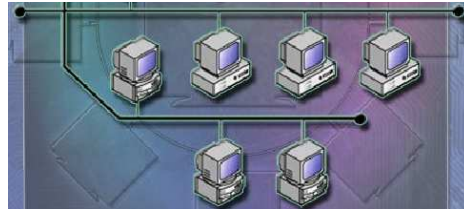
A physical topology defines the way in which computers, printers, and other devices are connected to a network.

- Bus
- Ring
- Star
- Hierarchical star
- Mesh



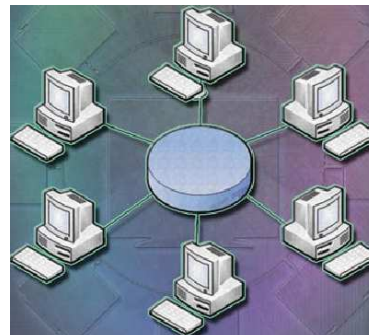
## Bus Topology

- Each computer connects to a common cable
- Cable connects one computer to the next
- Ends of the cable have a **terminator** installed to prevent signal reflections and network errors
- Only one computer can transmit data at a time or frames will collide and be destroyed
- Bus topology is rarely used today. Possibly suitable for a home office or small business with few hosts



## Ring Topology

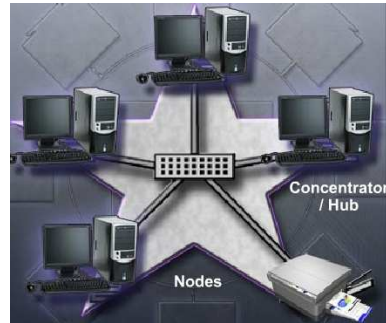
- Hosts are connected in a physical ring or circle.
- The ring has no beginning or end, so the cable does not need to be terminated.
- A special frame, a **token**, travels around the ring, stopping at each host.
- The advantage of a ring topology is that there are no **collisions**.
- There are two types of ring topologies:  
Single-ring and Dual-ring





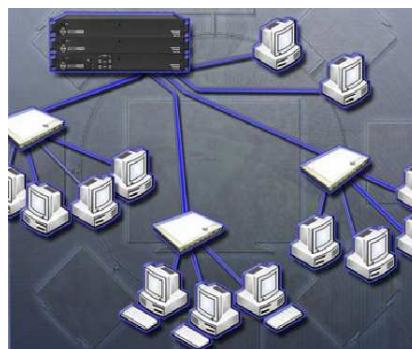
## Star Topology

- Has a central connection point: a hub, switch, or router
- Hosts connect directly to the central point with a cable
- Costs more to implement than the bus topology because more cable is used, and a central device is needed
- Easy to troubleshoot, since each host is connected to the central device with its own wire.



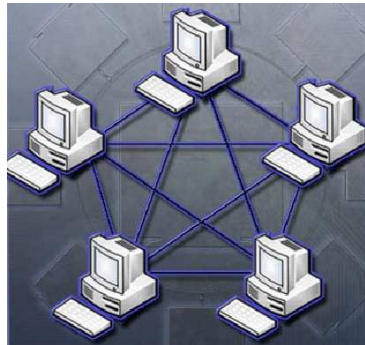
## Hierarchical or Extended Star Topology

- A star network with an additional networking device connected to the main networking device to increase the size of the network.
- Used for larger networks



## Mesh Topology

- Connects all devices to each other
- Failure of any cable will not affect the network
- Used in WANs that interconnect LANs
- Expensive and difficult to install because of the amount of cable needed
- The Internet is an example of a mesh topology
- Often used by governments when data must be available in the event of a partial network failure



## Logical Topologies

The two most common types of logical topologies are broadcast and token passing.

- In a **broadcast** topology, there is no order that the hosts must follow to use the network – it is **first come, first served** for transmitting data on the network.
- **Token passing** controls network access by passing an electronic token sequentially to each host. When a host receives the token, it can send data on the network. If the host has no data to send, it passes the token to the next host and the process repeats itself.

