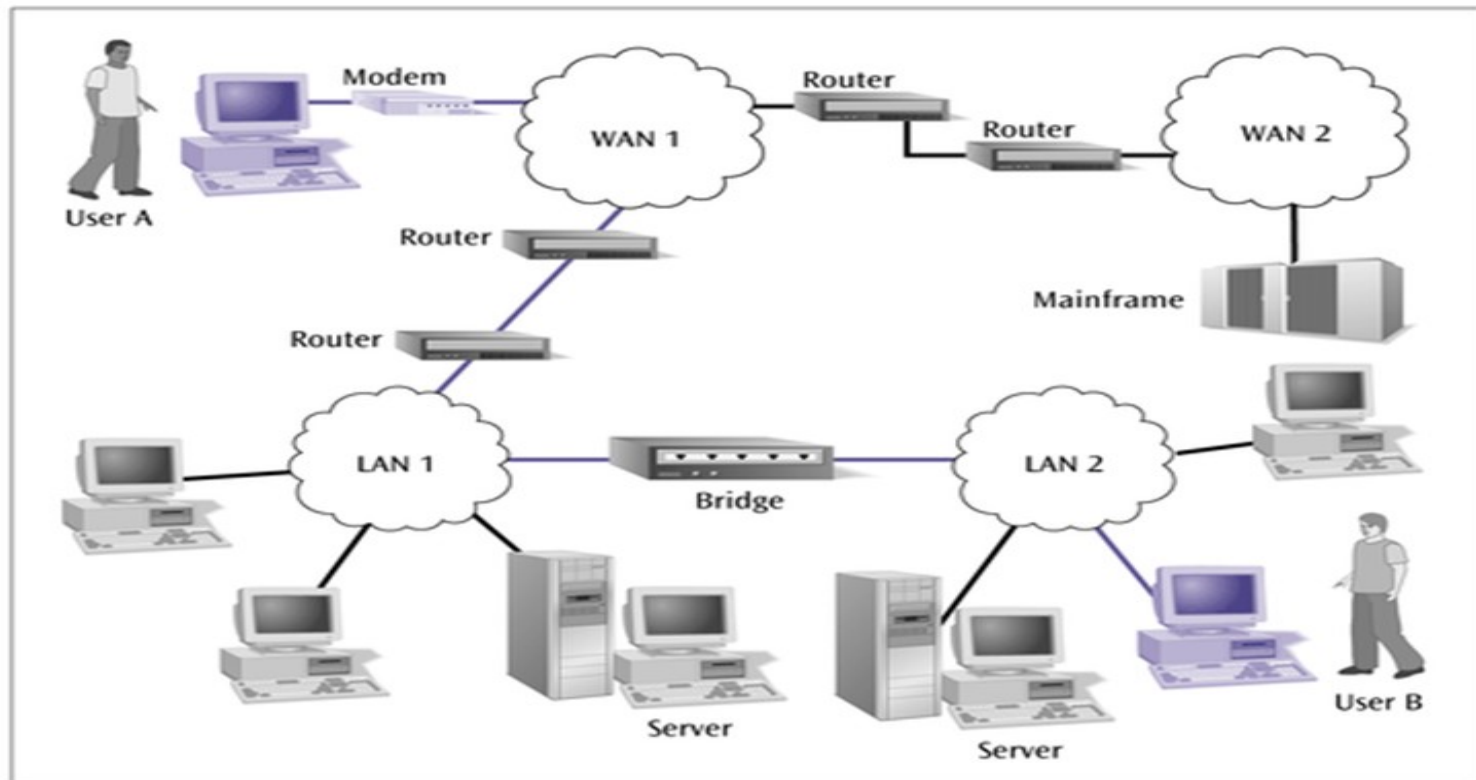




Data Communication and Computer Networks

Chapter 1 Part II Introduction to Computer Networks

An overall view of the interconnection between local area networks and wide area networks



Introduction to Computer Networks

- ❖ The term network means two or more connected computers (other communication devices) that can share resources like data, applications, office machines, an Internet connection, or some combination of these. **OR**
- ❖ Computer network to mean a collection of autonomous computers interconnected by a single technology.
- ❖ connecting together of computers and other devices is called a **network**, and the concept of connected computers sharing resources is called **networking**.
- ❖ The connection be via a copper wire, fiber optics, microwaves, infrared, Wi-Fi and communication satellites can also be used.
- ❖ Networks come in many sizes (small, medium or large), shapes (physical and logical structure) and forms.

Introduction to Computer Net cont'd...

- ❖ Two computers are said to be interconnected if they are able to exchange information.
- ❖ Components of a compute networks.

Hardware:

- *Computer*
- *Network card*
- *Routers*
- *Modem ...*

Media:

- *Cable*
- *Wire*
- *Microwave ...*

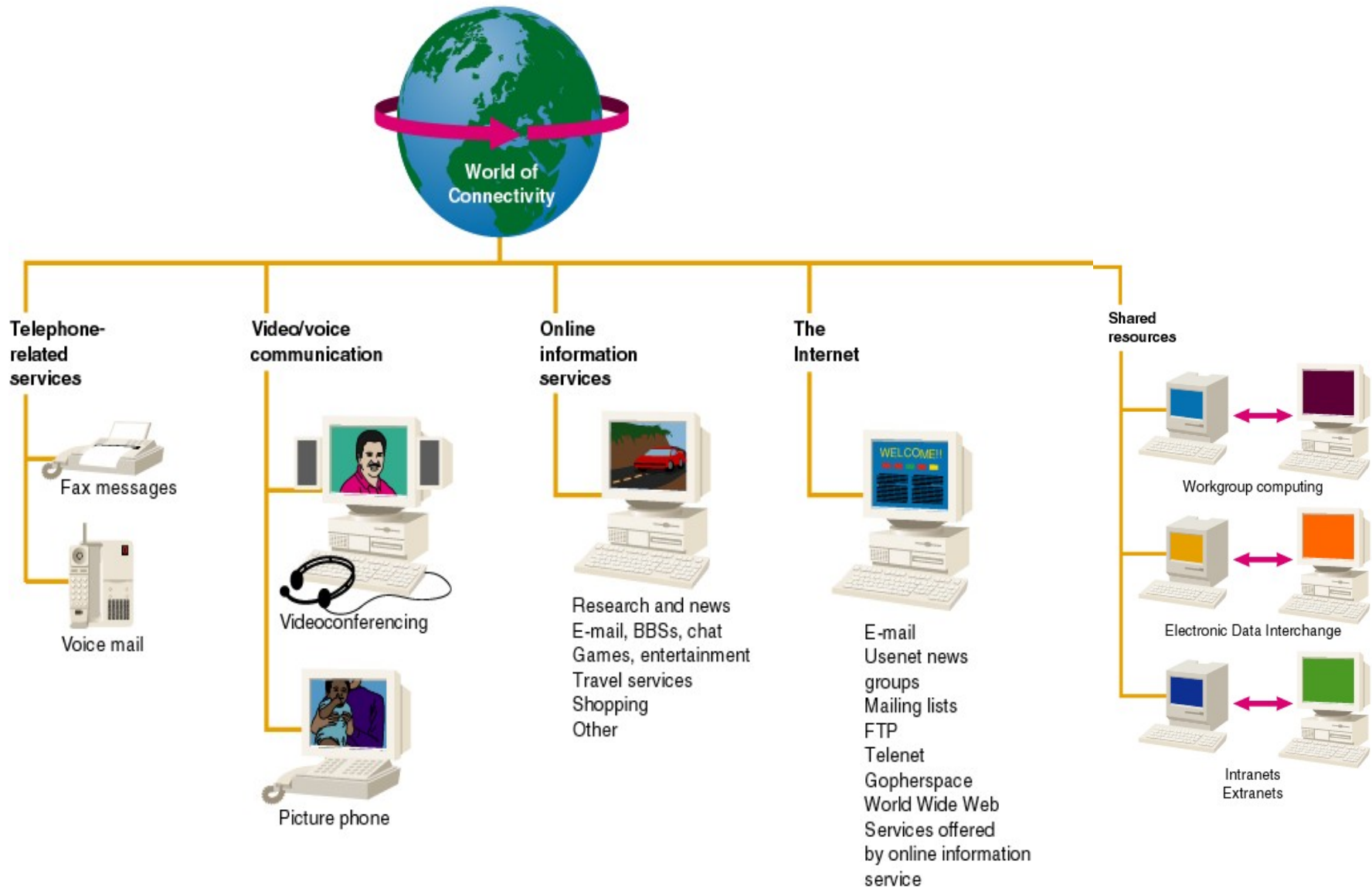
Software:

- *Network OS*
- *Utilities ...*

Network Design:

- *Logical layout*
- *Physical layout ...*

Uses of Computer Networks



Contd.

1. Resource sharing

- ❖ The goal of network is to make all programs, equipment, and especially data available to anyone on the network without regard to the physical location of the resource and the user.
- ❖ An obvious and widespread example is having a group of office workers share a common **printer**.
- ❖ None of the individuals really needs a private printer, and a high-volume networked printer is often cheaper, faster, and easier to maintain than a large collection of individual printers.
- ❖ **Information sharing** is more important than physical resource sharing
- ❖ To undertake parallel processing
- ❖ To share databases

Contd.

2. Means of communication

- E-mail
- Videoconferencing
- Chatting
- E-commerce
- Game
-

3. Centralizing administration and support

- Database
- Banks
-

Applications of Computer Networks

- ❖ Business application
- ❖ Home application
 - Internet access
 - Entertainment
 - Ubiquitous computing
 - Radio Frequency Identification (RFID)
- ❖ Wireless network
- ❖ Sensor network
- ❖ Wearable computers
- ❖ Science and Research
- ❖ Transportation
- ❖ Weather forecasting and others.

Introduction to computer Net cont'd...

Social Issues

- ❖ Computer networks allow ordinary citizens to distribute and view content in ways that were not previously possible.
- ❖ Social networks, message boards, content sharing sites, and a host of other applications allow people to share their views.
- ❖ The trouble comes with topics that people actually care about, like politics, religion, or sex.
- ❖ The other issue is copyright, to handle this some automated systems that search peer-to-peer networks and fire off warnings to network operators and users who are suspected of trespassing copyright.
- ❖ **Privacy** also a big problem in this regard.

For example, Google can read your email (at least the subject in order) and show you advertisements based on your interests (i.e. information domain) if you use its email service, **Gmail**. However, it is totally the violation of individuals as well as companies privacy right, stated under legal documents and constitutions.

Network Types

- There are basically **four categories** of networks based on its size and geographical coverage.
 1. Personal Area network
 2. Local Area Network (LAN)
 3. Metropolitan Area Network (MAN)
 4. Wide Area Network (WAN)

Introduction to Computer net cont.....

Computer Network

Types

Personal Area Networks

- A personal area network (PAN) is a computer network used for data transmission amongst devices such as computers, telephones, tablets and personal digital assistants.
- Can cover an area 0- 10 M

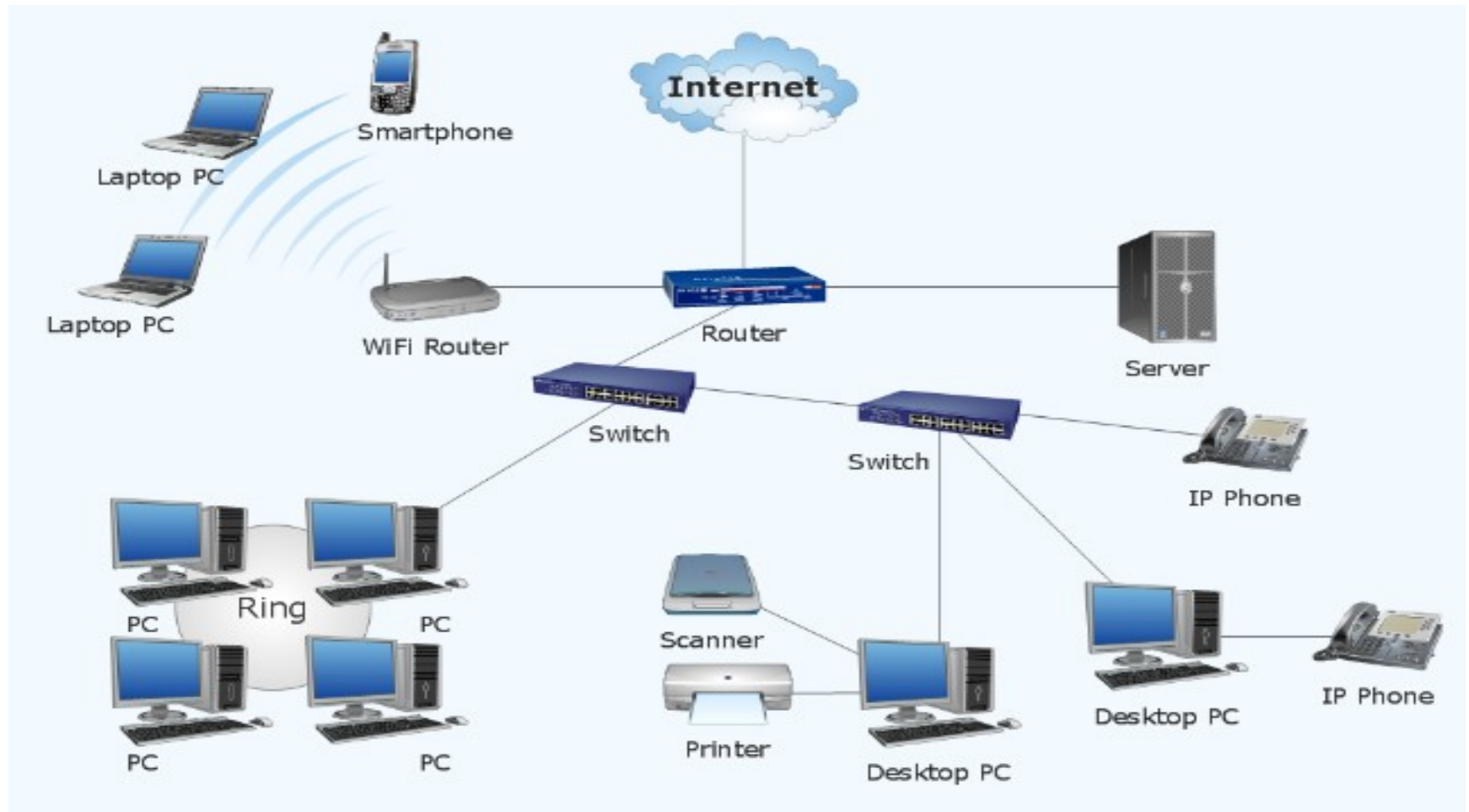


Local area network

(LAN)

- ❖ A **local area network (LAN)** is the basic building block of any computer network.
- ❖ A LAN can range from simple (two computers connected by a cable) to complex (hundreds of connected computers and peripherals throughout a major corporation).
- ❖ The distinguishing feature of a LAN is that it is confined to a **limited geographic area and the topology it used**.
- ❖ A local area network (LAN) is usually privately owned and links the devices in a single office, factory building, or campus.
- ❖ LANs are widely used to connect personal computers, laptop, PDA, Smart phones and other consumer electronics to let them share resources and exchange information.
- ❖ Currently, LAN size is limited to a few **kilometers**
- ❖ Early LANs had data rates in the 4 to 16 megabits per second (Mbps) range. Today, however, speeds are normally **100 or 1000 Mbps**

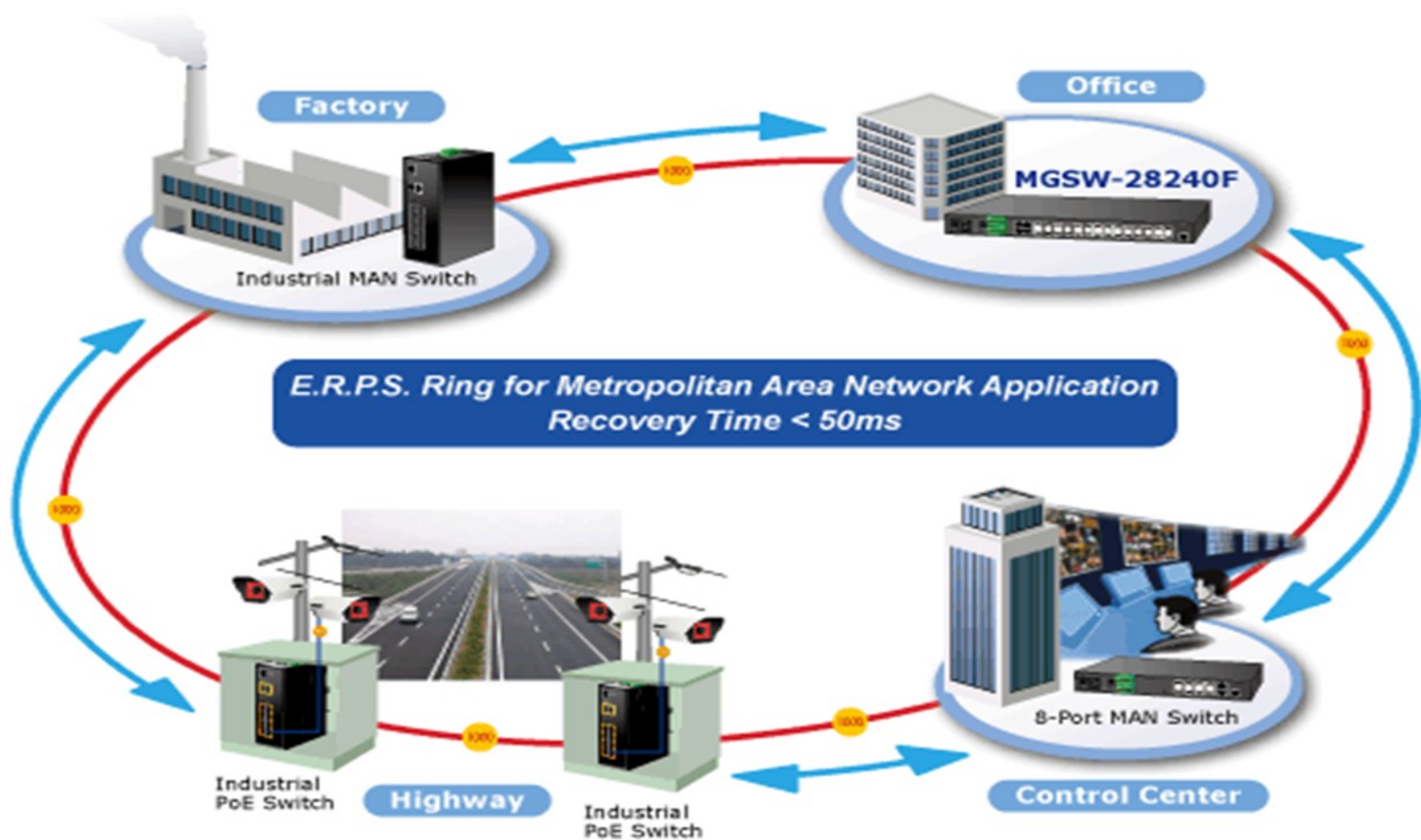
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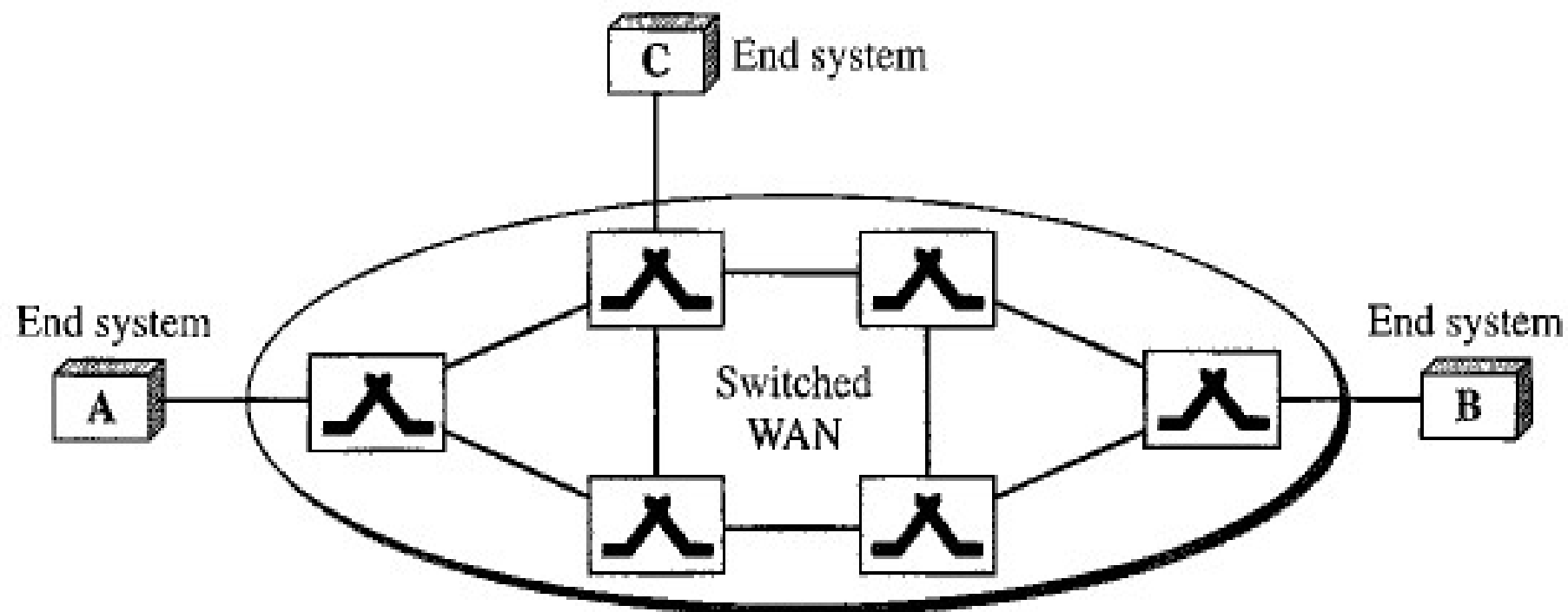
Metropolitan Area Network (MAN)

- ❖ A metropolitan area network (MAN) is a network with a size between a LAN and a WAN.
- ❖ It normally covers the area inside a **town or a city**.
- ❖ It is designed for customers who need a **high-speed connectivity**, normally to the Internet, and have endpoints spread over a city or part of city.
- ❖ A good example of a MAN is the part of the telephone company network that can provide a high-speed **DSL line** to the customer.
- ❖ Another example is the **cable TV** network that originally was designed for cable TV, but today can also be used for high-speed data connection to the Internet.
- ❖ Recently MAN develop in high-speed, which has been standardized as IEEE 802.16 and is popularly known as WiMAX (Worldwide Interoperability for Microwave Access).

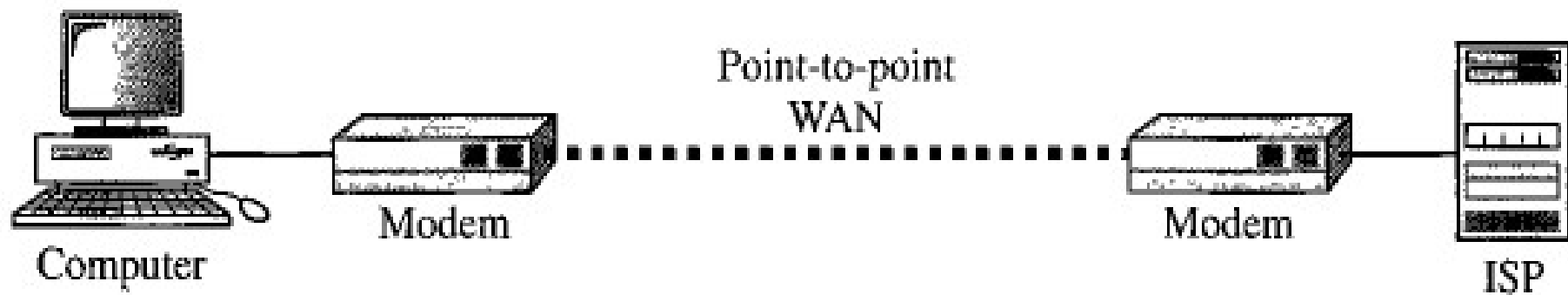
MAN cont'd



- ❖ A **wide area network (WAN)** provides long-distance transmission of data, image, audio, and video information over large geographic areas that may comprise a country, a continent, or even the whole world.
- ❖ A WAN can be as complex as the **backbones** that connect the Internet or as simple as a **dial-up line** that connects a home computer to the Internet. We normally refer to the first as a **switched WAN** and to the second as a **point-to-point WAN**.
- ❖ The switched WAN connects the end systems, which usually comprise a router (internetworking connecting device) that connects to another LAN or WAN.
- ❖ The point-to-point WAN is normally a line leased from a telephone or cable TV provider that connects a home computer or a small LAN to an Internet service provider (ISP). This type of WAN is often used to provide Internet access.
- ❖ Cover an area >50kms



a. Switched WAN



b. Point-to-point WAN

Network type based on connection

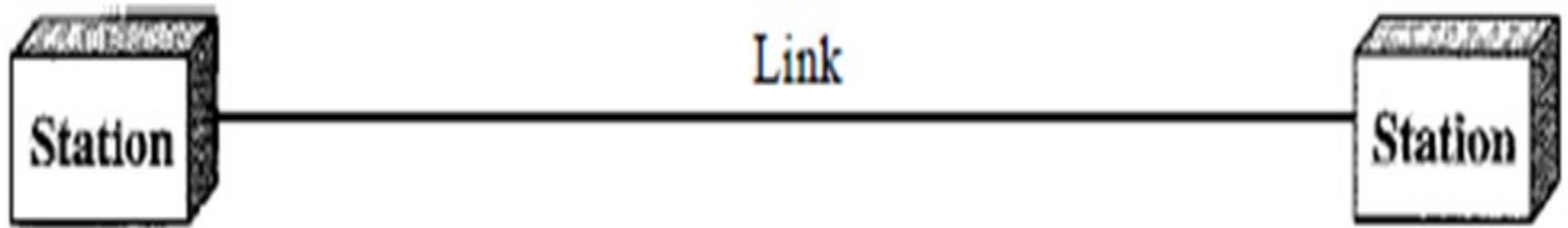
- A network is two or more devices connected through **links**.
- A link is a communications pathway that transfers data from one device to another.
- For visualization purposes, it is simplest to imagine any link as a line drawn between two points.
- For communication to occur, two devices must be connected in some way to the same link at the same time.
- There are two possible types of connections: **point-to-point** and **multipoint**.

Point-to-Point

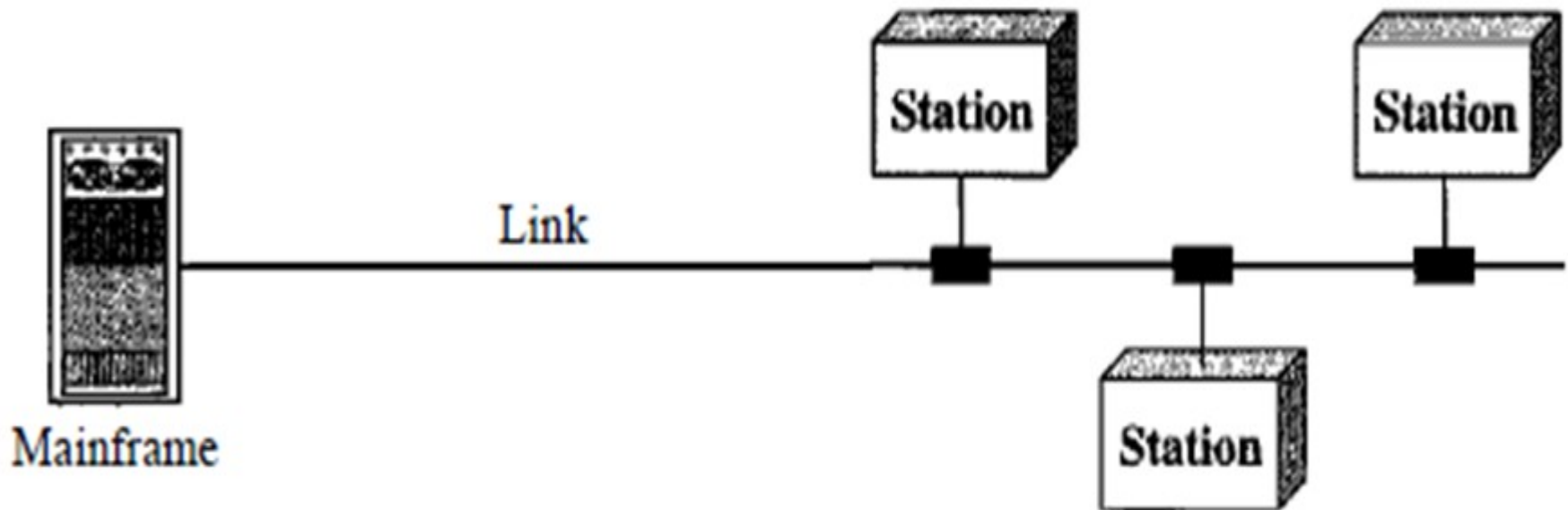
- A point-to-point connection provides a **dedicated link** between two devices.
- The entire capacity of the link is reserved for transmission between those two devices.
- Most point-to-point connections use an actual length of wire or cable to connect the two ends, but other options, such as microwave or satellite links, are also possible.
- When you change television channels by **infrared remote control**, you are establishing a point-to-point connection between the remote control and the television's control system.

Multipoint

- A multipoint (also called multidrop) connection is one in which more than two specific devices **share a single link**.
- In a multipoint environment, the capacity of the channel is shared, either **spatially** or **temporally**.
- If several devices can use the link simultaneously, it is a *spatially shared* connection.
- If users must take turns, it is a *timeshared connection*.



a. Point-to-point



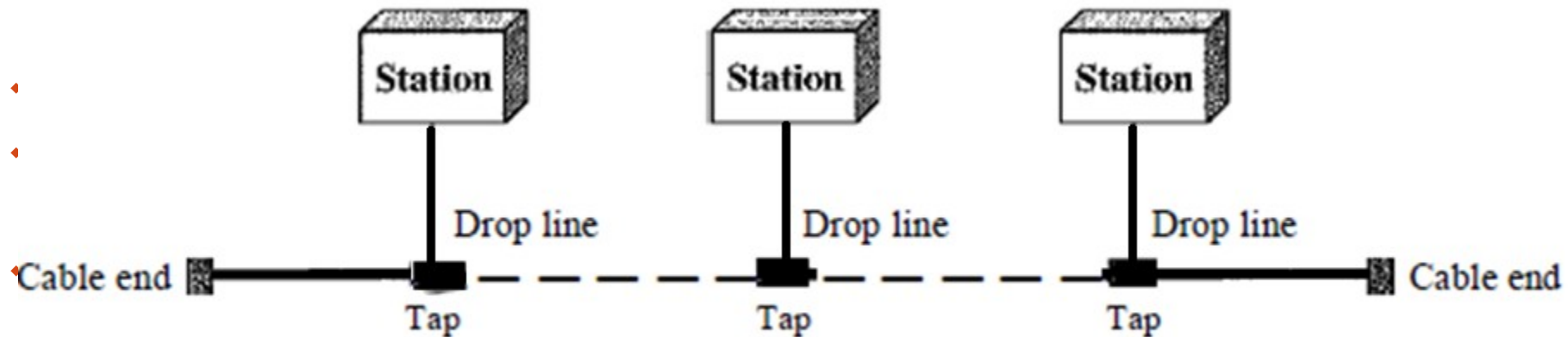
b. Multipoint

Network Topology

- ❖ The term **topology** refers to the way in which a network is laid out physically. Two or more devices connect to a link; two or more links form a topology.
- ❖ The topology of a network is the **geometric representation** of the relationship of all the links and linking devices (usually called **nodes**) to one another.
- ❖ Physical and logical topologies that are very different.
 - Physical topology refers to the way in which the endpoints, or stations, attached to the network are interconnected.
 - Logical topology refers the way of data transmission among communication device on the existing physical topology
- ❖ There are five basic topologies possible: mesh, star, bus, ring and hybrid .

Bus Topology

- ❖ Full-duplex operation between the station and the tap allows data to be transmitted onto the bus and received from the bus.
- ❖ A bus topology, is multipoint connection.
- ❖ One long cable acts as a **backbone** to link all the devices in a network
- ❖ Bus topology uses CSMA/CD, a protocol that helps devices share the bandwidth evenly without having two devices transmit at the same time on the network medium.
- ❖ CSMA/CD was created to overcome the problem of those collisions that occur when packets are transmitted



Advantages and Disadvantages of Bus Topology

Advantages of Bus topology

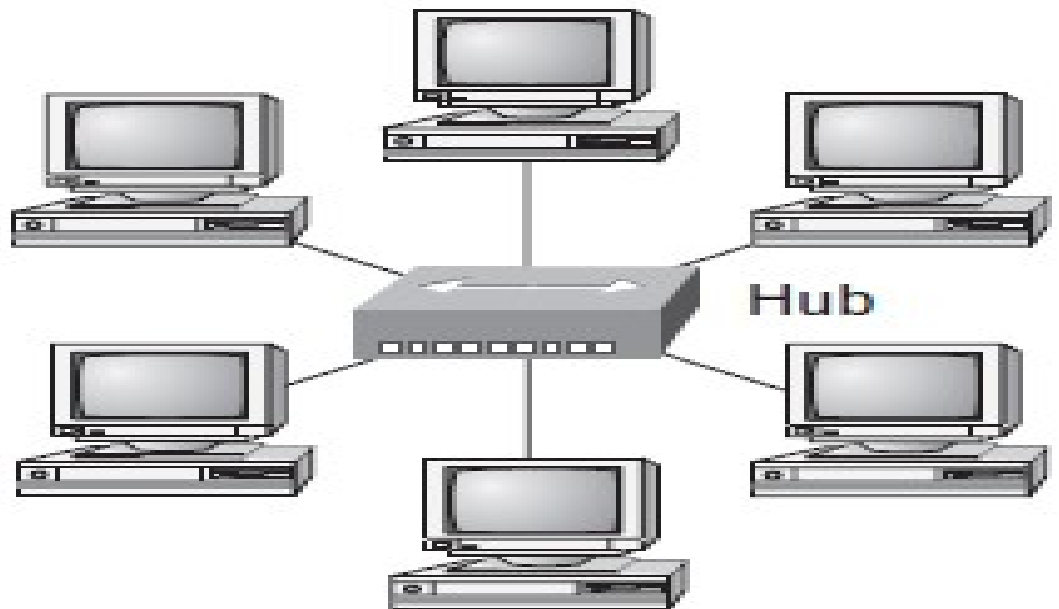
- ✓ **Ease of installation.**
- ✓ **uses less cabling** than mesh or star topologies
- ✓ Each drop line has to reach only as far as the nearest point on the backbone.

Disadvantages of Bus topology

- ✓ **difficult reconnection** and **fault isolation**. A bus is usually designed to be optimally efficient at installation.
- ✓ It can therefore be difficult to add new devices.
- ✓ In addition, a fault or break in the bus cable **stops all transmission**, even between devices on the same side of the problem.
- ✓ Adding new devices may therefore require modification or replacement of the backbone.

Star Topology

- ❖ In a **star topology**, each device has a dedicated **point-to-point** link only to a central controller, usually called a hub and it is full duplex.
- ❖ The term *dedicated* means that the link carries traffic only between the two devices it connects.
- ❖ The devices are not directly linked to one another.
- ❖ Unlike a mesh topology, a star topology does not allow direct traffic between devices.
- ❖ The controller acts as an exchange: If one device wants to send data to another, it sends the data to the other controller.
- ❖ There are two alternative approaches:
 - ✓ One approach is for the hub to be a dedicated device (using hub).
 - ✓ Another approach is for each device to have its own dedicated link to the central controller. An incoming frame is retransmitted on an output link.



Advantest and Disadvantages of Star

Advantages of Star topology

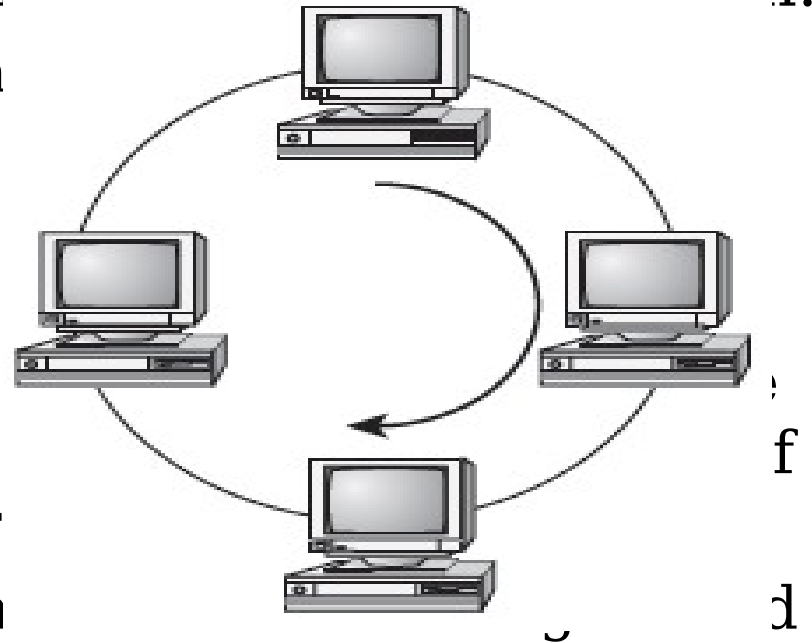
- ✓ A star topology is less expensive than a mesh topology.
- ✓ Easy to install and reconfigure.
- ✓ Far less cabling needs to be housed,
- ✓ Other advantages include robustness. If one link fails, only that link is affected. All other links remain active.

Dis advantages of star Topology

- ✓ **Dependency of the whole topology on one single point,** the hub. If the hub goes down, the whole system is dead.
- ✓ Each node must be linked to central hub for this reason, often more cabling is required in a star than in some other topologies (such as ring or bus).

Ring Topology

- ❖ In a **ring topology**, each device has a **dedicated point-to-point** connection with only the two devices on either side of it.
- ❖ A signal is passed along the ring in one direction, from device to device, until it reaches its destination.
- ❖ Computers are connected on a ring. Unlike the bus topology, there
- ❖ Signals travel around the loop through each computer
- ❖ The method by which the data is sent around the ring is called token passing. A token is a special bit that contains control information.
- ❖ Each computer acts as a repeater. It receives the signal from the previous computer and sends it to the next computer.



Advantages and Disadvantages of Ring

Advantages of Ring Topology

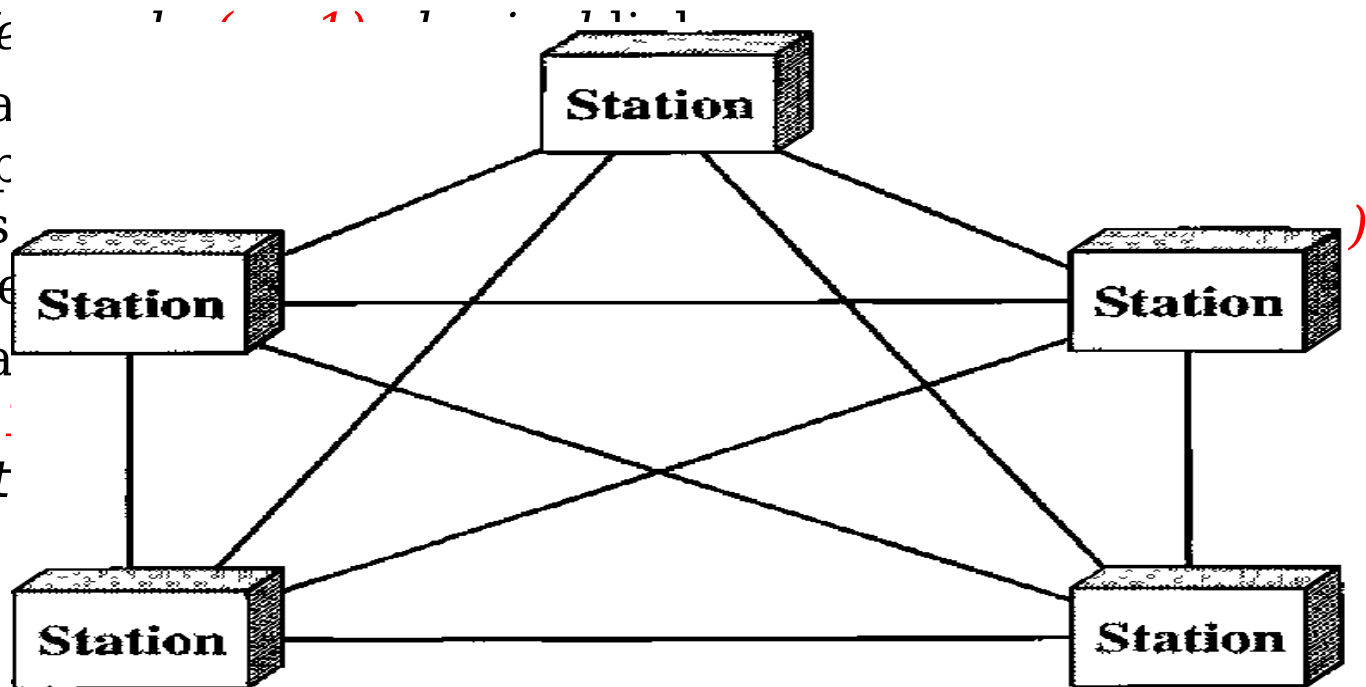
- ❖ A ring is relatively **easy to install** and **reconfigure**. Each device is linked to only its immediate neighbors (either physically or logically).
- ❖ To add or delete a device requires changing only two connections.
- ❖ In addition, fault isolation is simplified.

Disadvantages of Ring Topology

- In a simple ring, a **break in the ring** (such as a disabled station) can disable the entire network.
- This weakness can be solved by using a **dual ring** or a switch capable of closing off the break.
- Today, the need for higher-speed LANs has made this topology less popular.

Mesh topology

- In a **mesh topology**, every device has a dedicated point-to-point link to every other device.
- To find the number of physical links in a fully connected mesh network with n nodes, we first consider that each node must be connected to every other node.
- **Node 1** must be connected to $n - 1$ nodes, **node 2** must be connected to $n - 1$ nodes, and finally **node n** must be connected to $n - 1$ nodes. We
- However, if each link is bidirectional (duplex-mode), then the number of links is $\frac{n(n-1)}{2}$. In other words, each node must have $n - 1$ links to the other $n - 1$ stations.



Advantages and Disadvantages of Mesh Topology

Advantages

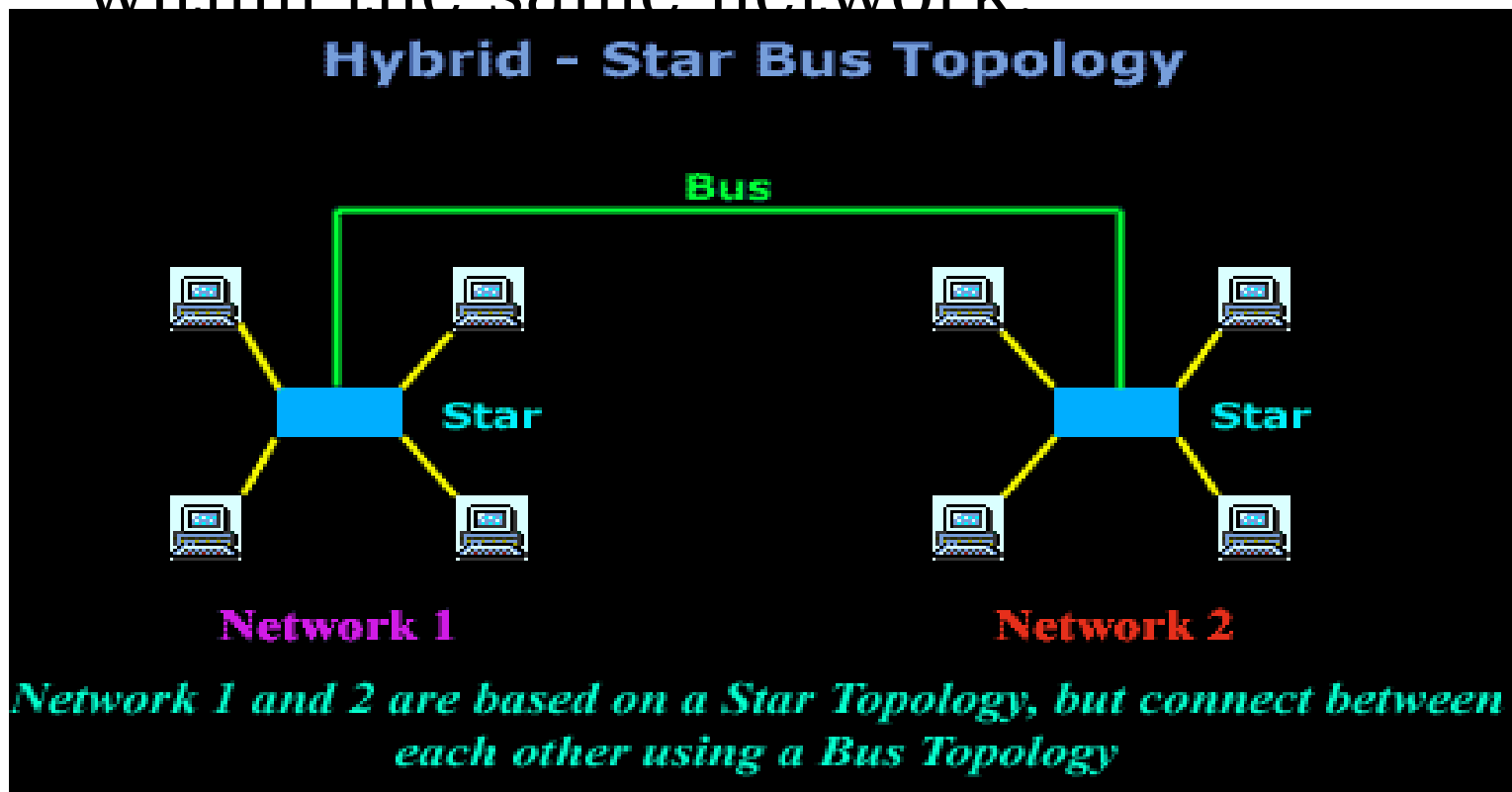
- ❖ **Eliminating the traffic problems** that can occur when links must be shared by multiple devices.
- ❖ mesh topology is **robust**. If one link becomes unusable, it does not incapacitate the entire system
- ❖ Third, there is the advantage of **privacy** or **security**. When every message travels along a dedicated line, only the intended recipient sees it. Physical boundaries prevent other users from gaining access to messages.

Disadvantages

- ❖ The main disadvantages of a mesh are related to the **amount of cabling and the number of I/O ports required**.
- ❖ First, because every device must be connected to every other device, **installation and reconnection are difficult**.
- ❖ Second, the **sheer bulk of the wiring** can be greater than the available space (in walls, ceilings, or floors) can accommodate.
- ❖ Finally, the hardware required to connect each link (I/O ports and cable) can be **prohibitively expensive**

Hybrid Topology

- ❖ Hybrid topology is a combination of two or more types of physical or logical network topologies working together within the same network.



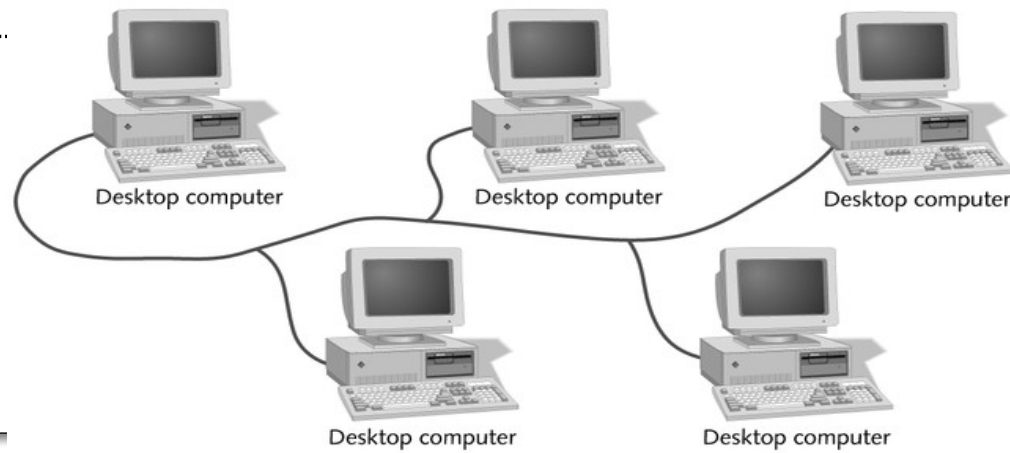
Selecting the Right Topology

- ❖ In the process of selecting appropriate network type you must first answer the following questions:
 - How much cash do you have?
 - How much fault tolerance do you really need?
 - How scalable does your network need to be?
 - How easy the installation and maintenance of a network?

Network Models by Capability

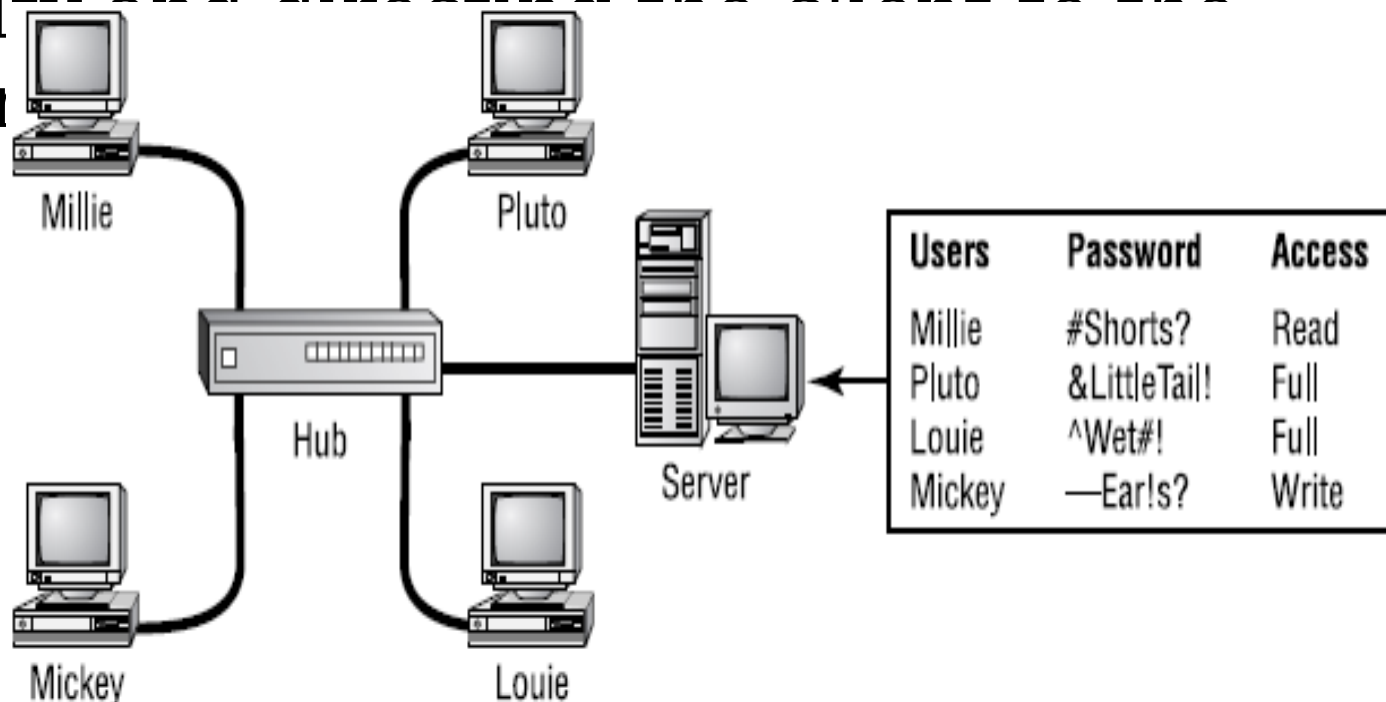
1. Peer to Peer (P2P)

- ❖ Computers on the network communicate with each others as equals and each computer is responsible for making its own resources available to other computers on the network.
- ❖ The computers existing in a peer-to-peer network can be client machines that access resources and server machines that provide them to other computers.
- ❖ This works really well if there's not a huge number of users on the network, each user handles backing things up local. require a lot of security.



2. Client-server model

- ❖ Two clients using a single server at a time
- ❖ Instead of the request going directly to the machine with the desired resource, a client machine's request for a resource goes to the main server, which responds by handling security and directing the client to the resource



Client/Server vs. Peer-to-Peer:

Advantages and Disadvantages Client/Server Model	Advantages and Disadvantages Peer-to-Peer Model
--	---

Advantages:

- Very secure OS.
- Better performance.
- Centralized servers, easy to manage.
- Centralized backups.
- High reliability.

Disadvantages:

- Expensive administration.
- More hardware intensive.

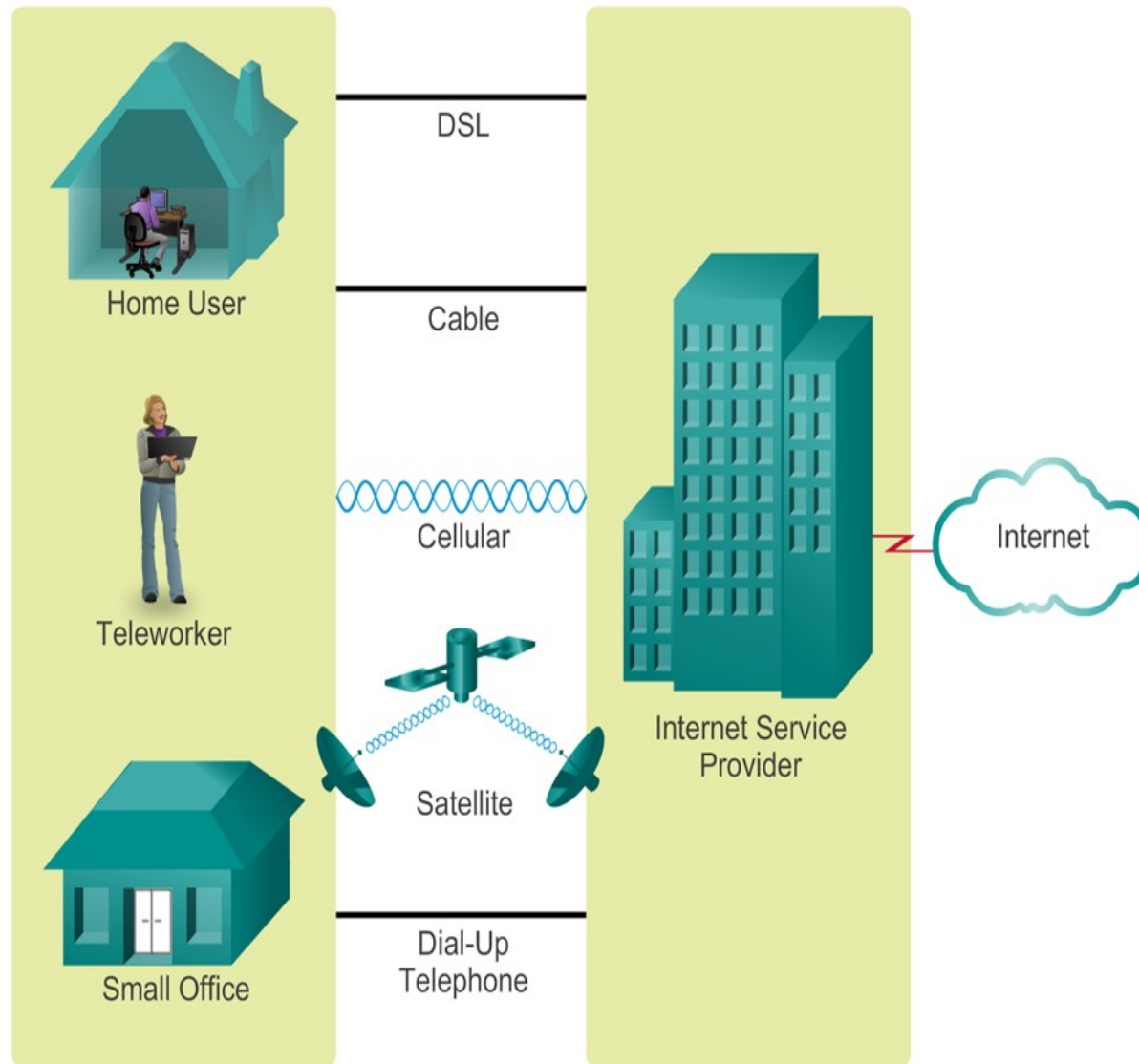
Advantages:

- Uses less expensive networks.
- Easy to administer.
- Contain both network operating system and application software.

▪ Ideal for small business and home users (up to 10 individual user computers).

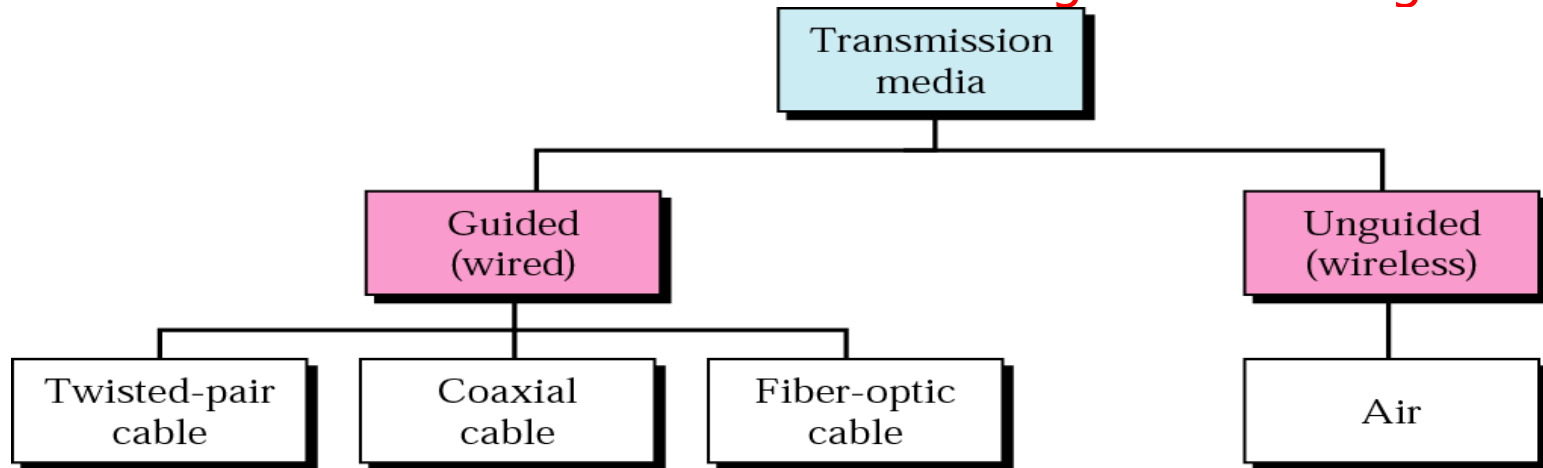
- Individual user performance easily affected.
- Not very secure.
- Hard to back up.

Connection Options



Transmission Medias

- ▮ The **transmission medium** is the physical path between transmitter and receiver in a data transmission system.
- ▮ Transmission media can be classified as **guided** or **unguided**.



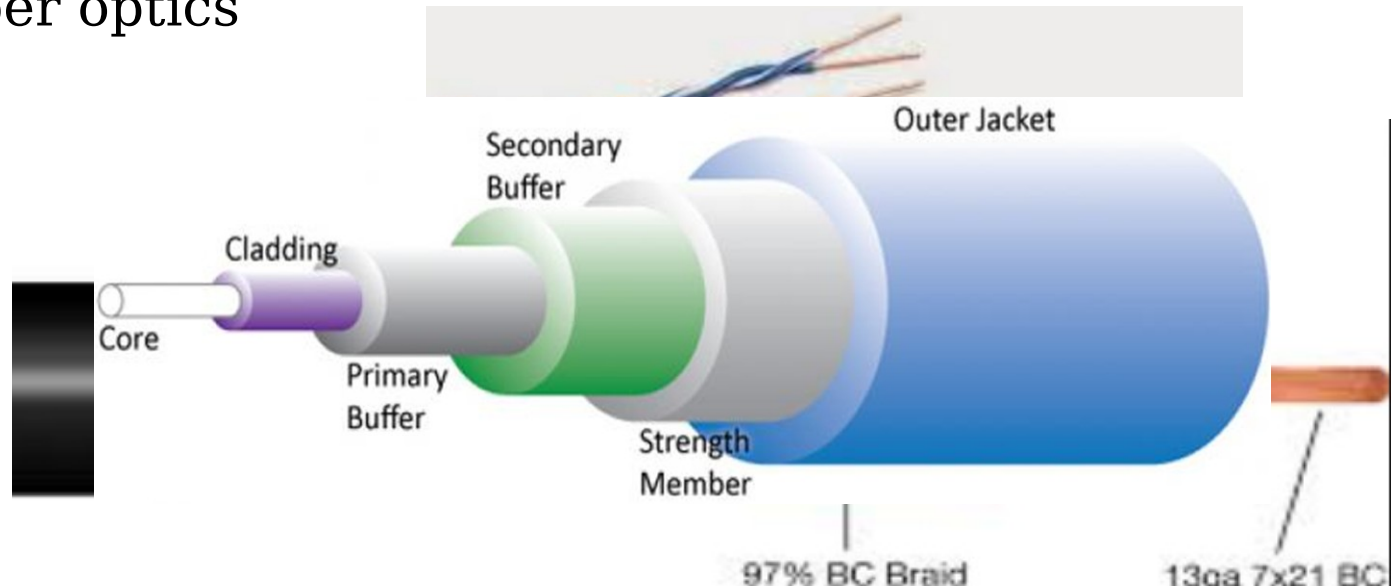
- ▮ In both cases, communication is in the form of **electromagnetic waves**.
- With guided media, the waves are **guided along a solid medium**, such as copper twisted pair, copper coaxial cable, and optical fiber.

GUIDED TRANSMISSION MEDIA

- ▮ For guided transmission media, the transmission capacity, in terms of either **data rate or bandwidth**, depends critically on the **distance** and on whether the medium is **point-to-point** or **multipoint**, such as in a local area network (LAN).
- ▮ Guided media, which are those that provide a conduit from one device to another, include **twisted-pair cable**, **coaxial cable**, and **fiber-optic cable**.
- ▮ A signal traveling along any of these media is **directed and contained** by the physical limits of the medium.
- ▮ Twisted-pair and coaxial cable use **metallic (copper) conductors** that accept and transport signals in the form of **electric current**.
- ▮ Optical fiber is a cable that accepts and transports signals in the form of **light**.

Guided Media cont'd.....

- Twisted Pair Cable
- Coaxial cable
- Fiber optics



Twisted-Pair Cable

- ▮ A twisted pair consists of two conductors (normally copper), each with its own **plastic insulation**, **twisted together**, as shown in the figure below.
- ▮ **One of the wires** is used to carry signals to the **receiver**, and the **other** is used only as a **ground reference**.
- ▮ The twisting tends to decrease the crosstalk interference between adjacent pairs in a cable.
- ▮ Ethernet operating over twisted-pair cabling is commonly used within a building for LANs supporting personal computers with the data rate of 100 Mbps to 10 Gbps.
- ▮ **Twisted pair may be used to transmit both analog (amplifiers in every 5 to 6 KM) and digital (repeaters in every 2 to 3 KM) transmission.**
- ▮ twisted pair cable is limited in distance, bandwidth, and data rate than others.



the transmission line and crosstalk from adjacent twisted pairs of twisted-pair cables.

Transmission Medias cont...

Types of Twisted Pair Cable

- Twisted pair cables are mainly categorized into two, namely, Shielded (STP) and Unshielded (UTP) Twisted Pair cable. Shielded twisted pair cable has three forms.
 1. Each pair of wires is individually shielded with metallic foil, generally referred to as foil twisted pair (FTP).
 2. There is a foil or braid shield inside the jacket covering all wires (as a group). This configuration is sometimes designated as screened twisted pair (F/UTP).
 3. There is a shield around the entire cable as well as around each individual pair, referred to as fully shielded twisted pair (S/FTP).



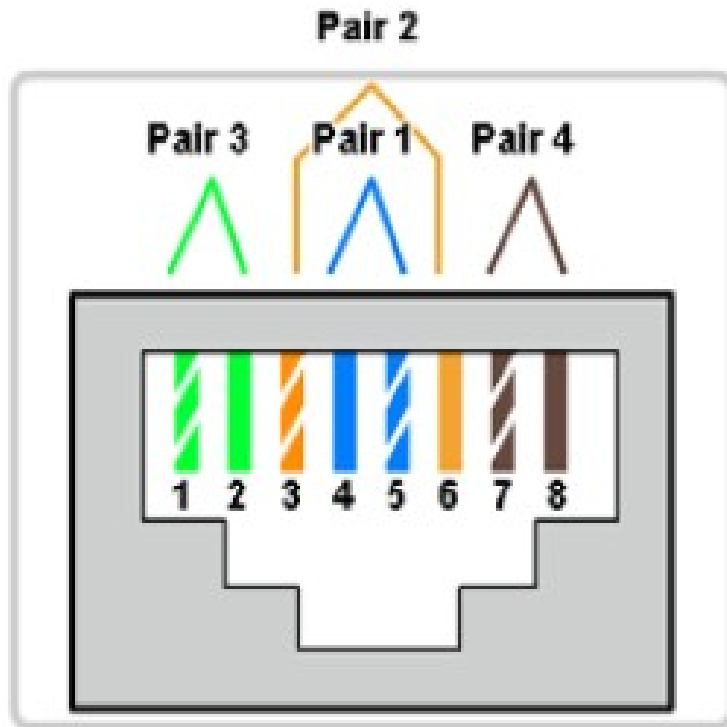
Transmission Medias cont.....

Twisted Pair Cabling

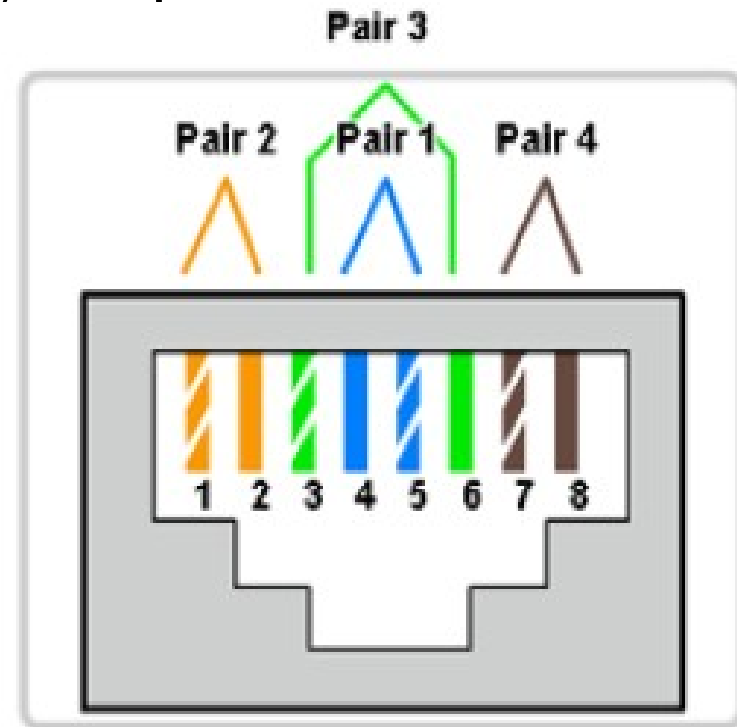
- Twisted pair cables are terminated with RJ-45 connectors, is a common copper-based medium for interconnecting devices in the network.
- Different situations may require different UTP

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T568A

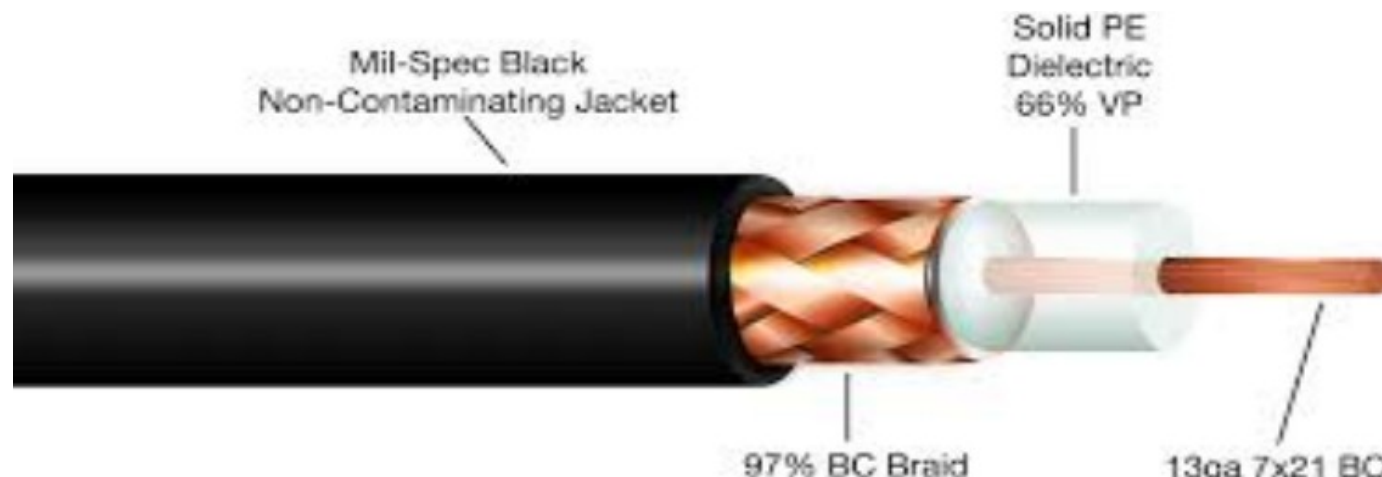


T568B

Transmission Medias cont.....

Coaxial cable

- Coaxial cable consists of two conductors, it is constructed to permit it to operate over a wider range of frequencies.
- It consists of a hollow outer cylindrical conductor that surrounds a single inner wire conductor.
- The inner conductor is held in place by insulating rings. The outer conductor is covered with a jacket or shield.



Transmission Medias cont....

Coaxial Cable cont.....

- Because of its shielded, concentric construction, coaxial cable is much less susceptible to interference and crosstalk than twisted pair.
- The principal constraints on performance are attenuation, thermal noise, and intermodulation noise.
 1. **Thin net cable(10base2)** : is a flexible coaxial cable about **0.64** centimeters (0.25 inches) thick. Carry a signal for 200 meters
 2. **Thick cable(10base5)** :is a relatively rigid coaxial cable about **1.27** centimeters (0.5 inches) in diameter. carry a signal for 500 meters .

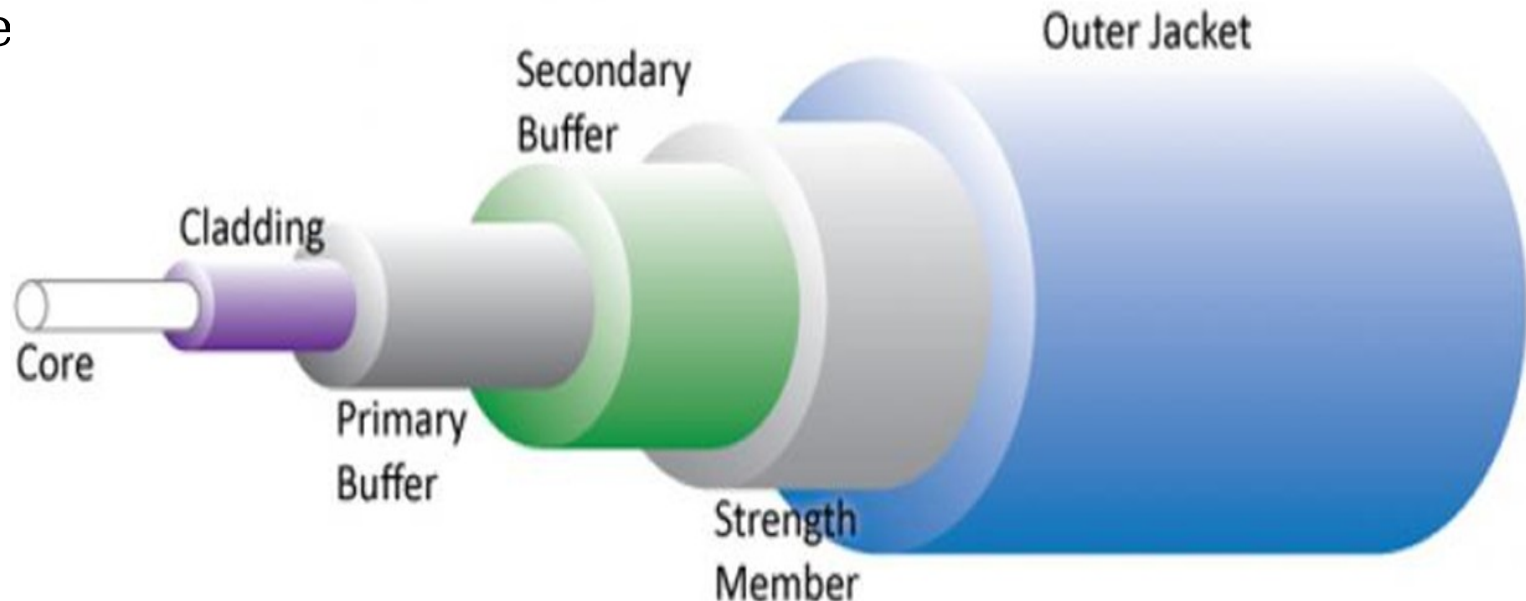
Applications of Coaxial Cable

- Television distribution

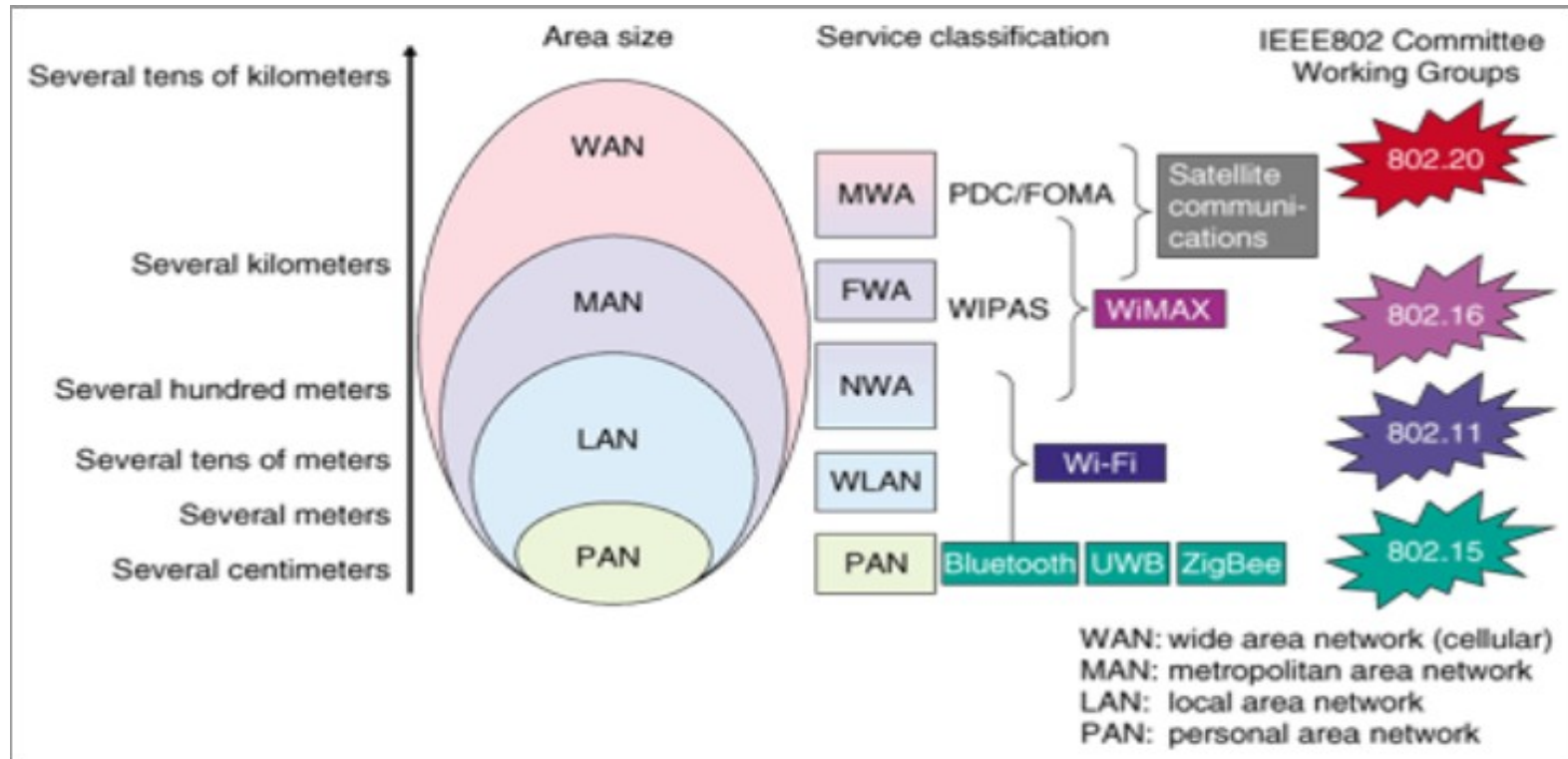
Transmission Medias cont....

Fiber Optics

- Fiber-optic cabling uses either glass or plastic fibers to guide light impulses from source to destination. The bits are encoded on the fiber as light impulses. Optical fiber cabling is capable of very large raw data bandwidth rates.
- An **optical fiber strand** (also called an *optical waveguide*) has a cylindrical shape and consists of three concentric sections: the



Unguided Media



Where:

MWA-Mobile Wireless Access

FWA-Fixed Wireless Access

NWA-Nomadic Wireless Access

Unguided Media cont...

Types of Wireless Networks

- Standards for wireless data communications cover both the Data Link and Physical layers. Four common standards are:
- IEEE 802.11 - is a Wireless LAN (WLAN) technology that uses a Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) media access process.
- IEEE 802.15 - Wireless WPAN, commonly known as "Bluetooth", uses a device pairing process to communicate over distances from 1 to 100 meters.
- IEEE 802.16 - Commonly known as WiMAX (Worldwide Interoperability for Microwave Access), uses a point-to-multipoint topology to provide wireless broadband access.
- Global System for Mobile Communications (GSM) - Includes Physical layer specifications that enable the implementation of the Layer 2 General Packet Radio Service (GPRS) protocol to provide data transfer over mobile cellular telephony networks.
- Other wireless technologies such as satellite communications provide data network connectivity for locations without

Unguided (Wireless) media cont....

- Wireless media carry electromagnetic signals at radio and microwave frequencies that represent the binary digits of data communications.
- Wireless data communication technologies are good in open environments. However, buildings and structures, and the local terrain, will limit the effective coverage. In addition, wireless is susceptible to different kinds interference from home appliances.
- Each frequency band has its advantages and disadvantages.
- Popular mobile systems congregate toward lower frequencies, lower frequencies mean longer wavelengths that travel further, but it has a bandwidth limitation.
- In contrast, higher frequencies can provide sufficient bandwidth but their shorter wavelengths make for shorter traveling distances.
- Unguided signals can travel from the source to destination in several ways: **ground propagation, sky propagation, and**

Unguided Media cont....

Wireless Propagation

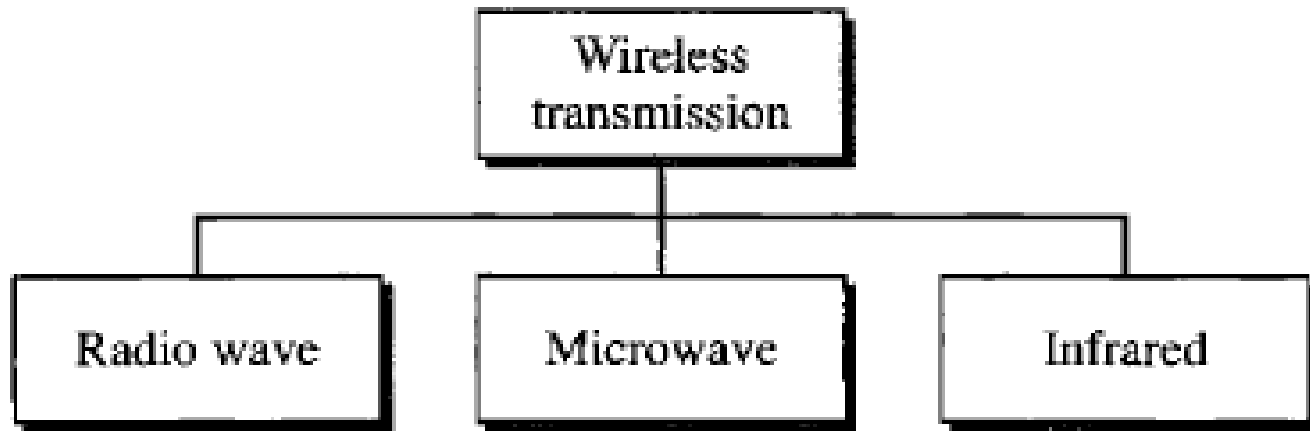
- A signal radiated from an antenna travels along one of three routes:
 - **Ground wave**: follows the contour of the earth and can propagate considerable distances. This effect is found in frequencies up to about 2 MHz (Low and Medium wave frequency range).
 - **Sky wave**: a signal from an earth-based antenna is reflected from the ionized layer of the upper atmosphere (ionosphere) back down to earth.
 - **Line of sight (LOS)**: Above 30 MHz communication must be by line of sight.
 - For satellite communication, a signal above 30 MHz is not reflected by the ionosphere and therefore a signal can be transmitted between an earth station and a satellite overhead that is not beyond the horizon.
 - For ground-based communication, the transmitting and receiving antennas must be within the effective range of the signal.

cont...

Antenna

- An antenna is electrical conductor(s) used either for radiating or collecting electromagnetic energy.
- For transmission of a signal, radio-frequency electrical energy from the transmitter is converted into electromagnetic energy by the antenna and radiated into the surrounding environment (atmosphere, space, water).
- For reception, electromagnetic energy impinging on the antenna is converted into radio-frequency electrical energy and fed into the receiver.
- In two-way communication, the same antenna can be and often is used for both transmission and reception.
- An antenna radiate signal in all direction, but not

Wireless Transmission Types



Performance metrics

- Bandwidth
- Throughput
- Latency
- Capacity

Radio wave 3KHz_1GHZ

- ground +sky propagation

Micro wave 1GZ-299 GHZ

- Sky+ line of sight

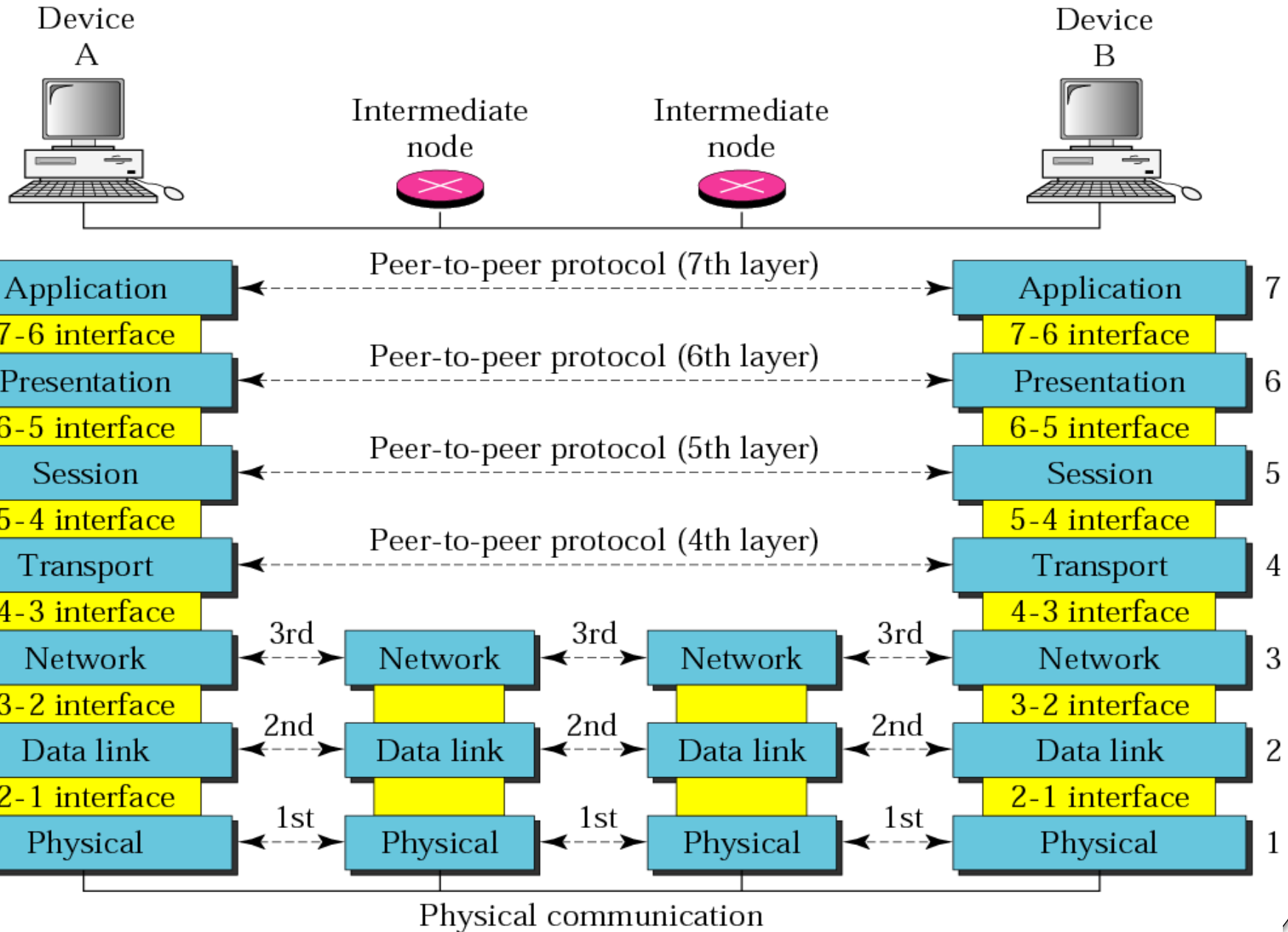
Infrared 300GHZ-400THZ

- Line of sight

Network Protocol Stacks

- **Protocol** is an agreement between the communicating parties on how communication is to proceed.
- A protocol layer can be implemented in software, in hardware, or in a combination of the two.
- A set of layers and protocols is called a **network architecture**.
- The specification of an architecture must contain enough information to allow an implementer to write the program or build the hardware for each layer so that it will correctly obey the appropriate protocol.
- A list of the protocols used by a certain system, one protocol per layer, is called a **protocol stack**.
- The entities comprising the corresponding layers on different machines are called peers. The peers may be software processes, hardware devices, or even human beings.

Contd.



Network Protocol Stack cont.....

The Need for Layer Architecture

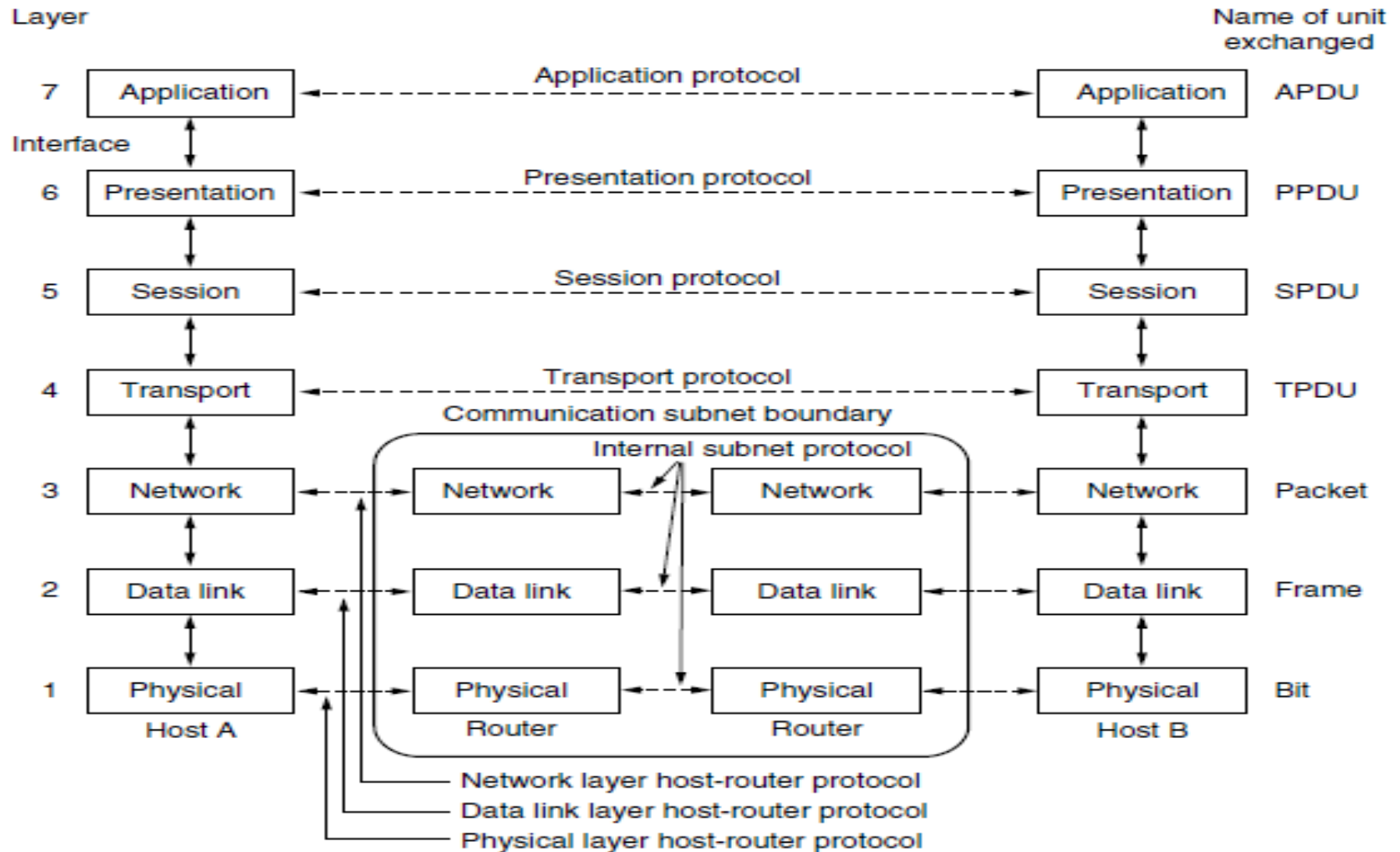
- We use layered architecture in networking for the following reasons:
 - It reduces design and implementation complexity of the software as well as the hardware.
 - It helps to easily replace one layer with a completely different protocol or implementation without affecting the upper or lower layers in the architecture.
 - Standards can be developed independently and simultaneously for each layer.
- Some researchers and networking engineers are strongly opposed to layering, because:
 - One layer may duplicate lower-layer functionality.
 - Functionality at one layer may need information that is present only in another layer; this violates the goal of separation of layers.

Network Protocol Stack cont....

Open System Interconnection (OSI) Reference Model

- It is considered as the primary architectural model for inter-computer communications. It ensures greater compatibility and interoperability between various types of network technologies.
- Divides the problem of moving information between computers over a network medium into SEVEN smaller and more manageable problems (modules).
- The model define how each layer communicates and works with the layers immediately above and below it.
- Each layer communicates with the same layer's software or hardware on other computers (on the other node).
- The lower 4 layers are concerned with the flow of data from end to end through the network.
- The upper three layers of the OSI model are orientated more toward services to the applications.
- Data is Encapsulated with the necessary protocol information as it moves down the layers before network transit.

Network Protocol Stack cont.....



NETWORK PROTOCOL STACK

cont.....

OSI Reference Model cont.....

- The principles that were applied to arrive at the seven layers:
 1. A layer should be created where a different abstraction is needed.
 2. Each layer should perform a well-defined function.
 3. The function of each layer should be chosen with an eye toward defining internationally standardized protocols.
 4. The layer boundaries should be chosen to minimize the information flow across the interfaces.
 5. The number of layers should be large enough that distinct functions need not be thrown together in the same layer out of necessity and small enough that the architecture does not become unwieldy.

Network Protocol Stack cont.....

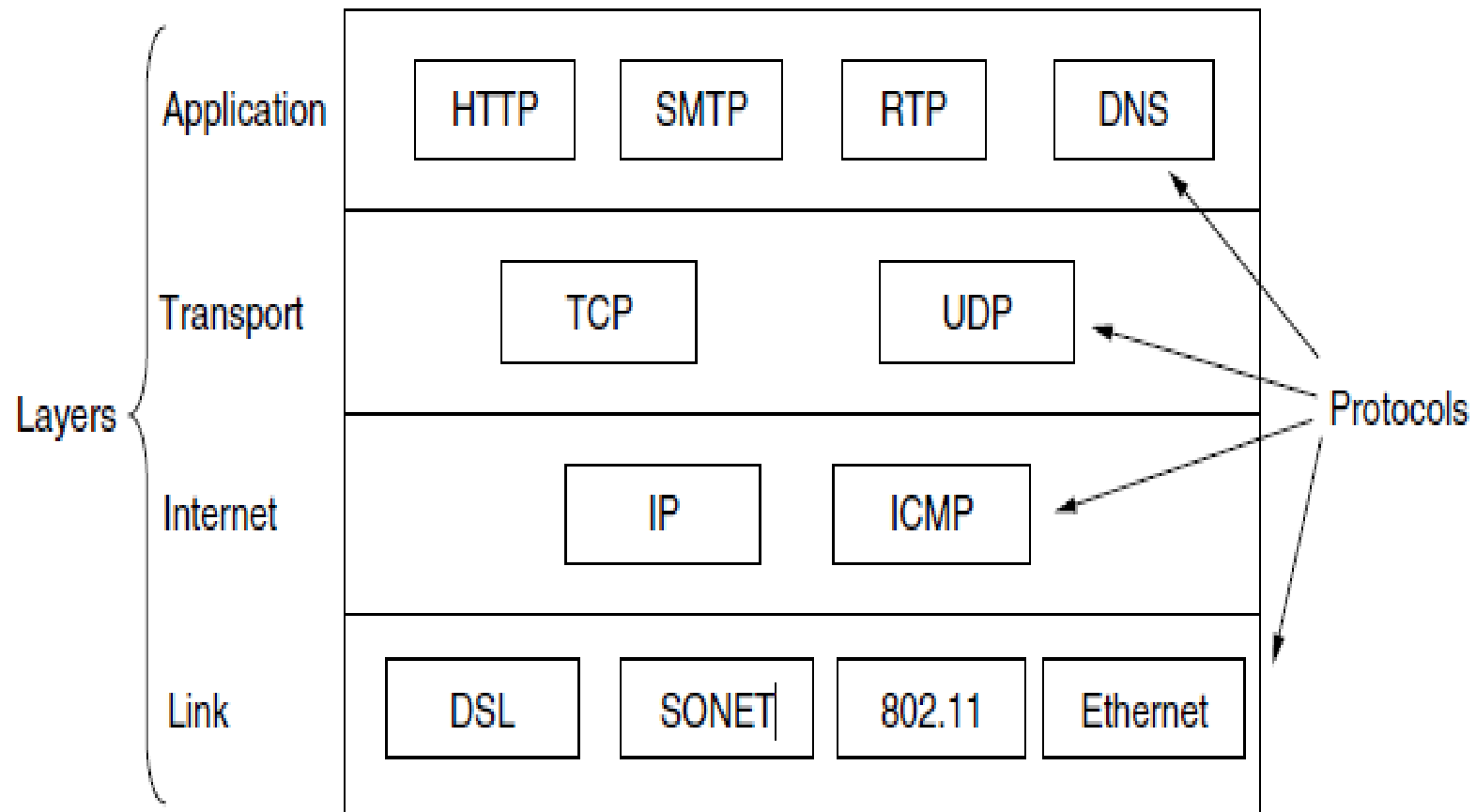
TCP/IP (Internet) Reference Model

- Used in the grandparent of all wide area computer networks, the Advanced Research Projects Agency Network (ARPANet).
- Developed by Department of Defense (DoD) to ensure and preserve data integrity as well as maintain communication in the time of catastrophic war.
- Condensed version of OSI model contains five layers instead of seven.
- It is independent of the Network access methods, Frame format, & Medium.

OSI	TCP/IP	Internet Protocol
Application	Application	Application
Presentation		
Session		
Transport	Transport	Transport
Network	Internet	Internet
Data Link	Link	Link
Physical		Physical

Network Protocol Stack cont.....

Protocols in TCP/IP Reference



Network Protocol Stack cont.....

Comparison of the OSI and TCP/IP Reference Models

- Three concepts (i.e. services, interfaces and protocols) are central to the OSI model. But the TCP/IP model did not originally clearly distinguish these concepts.
- The biggest contribution of the OSI model is that it makes the distinction between these three concepts explicit.
- Protocols in the OSI model are better hidden than in the TCP/IP model and can be replaced easily by new technology.
- The OSI reference model was devised before the corresponding protocols were invented.
- The downside of this ordering was that the designers did not have much experience with the

Comparison of the OSI and TCP/IP Reference Models

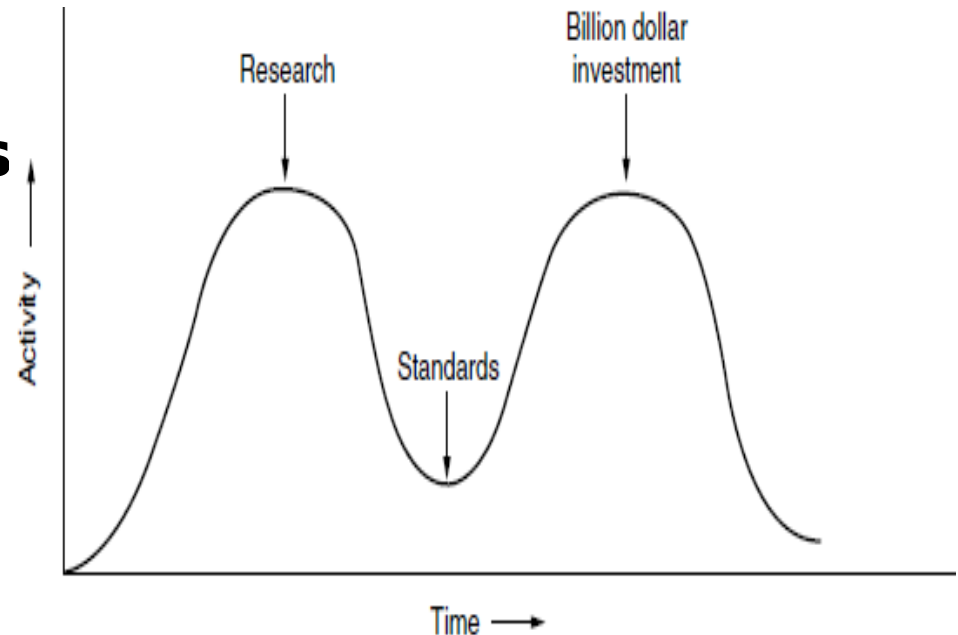
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- With TCP/IP the reverse was true. There was no problem with the protocols fitting the model. The only trouble was that the model did not fit any other protocol stacks.
- Another difference is OSI supports both connectionless and connection oriented communication in the network layer, but only connection-oriented communication in the transport layer and TCP/IP supports only connectionless in the network layer but both in the transport layer.

Network Protocol Stack cont.....

A Critique of the OSI Model and Protocols

1. **Bad timing.**
2. **Bad technology.**
3. **Bad implementations**
4. **Bad politics.**



- ❑ The choice of seven layers was more political than technical, and two of the layers (session and presentation) are nearly empty, whereas two other ones (data link and network) are overfull.

Network Protocol Stack cont.....

A Critique of the TCP/IP Reference Model

- Not clearly distinguish the concepts of services, interfaces, and protocols.
- Not much of a guide for designing new networks using new technologies.
- It is not general and is poorly suited to describing any protocol stack other than TCP/IP. For example, Bluetooth is completely impossible.
- The link layer is not a layer but it is an interface (between the network and data link layers).
- The TCP/IP model does not distinguish between the physical and data link layers. These are completely different.
- The protocol implementations were then distributed free, which resulted in their becoming

Next
Chapter Two
Data Link Layer