



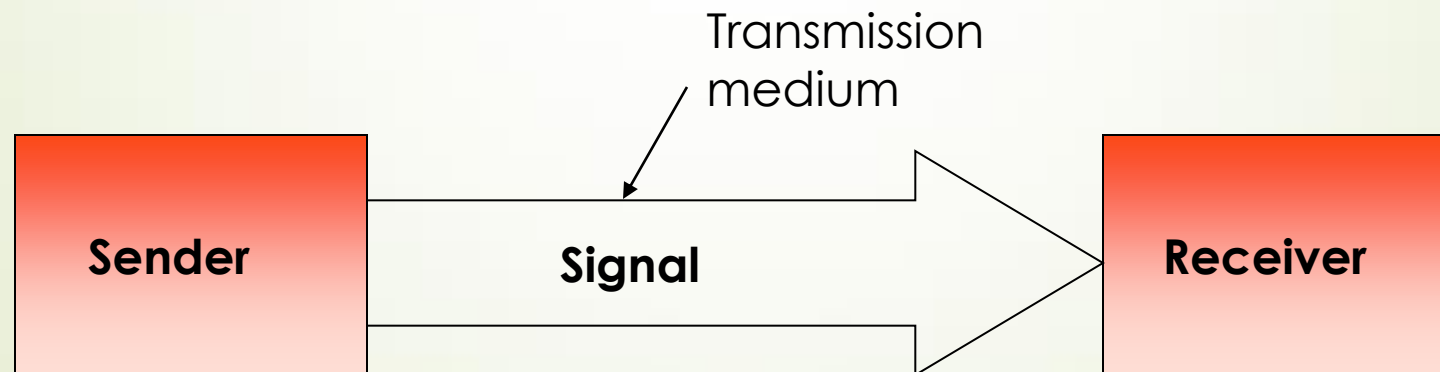
# Modern Telecommunication Systems

## Lecture 1

Engr. Madeha Mushtaq  
Department of Computer Science  
Iqra National University

# Communication

- Communication is a process in which information is transferred from source to destination.
- We have been using communication technology for years.
- The message (data and information) is communicated via signal.
- The transmission medium “carries” the signal.



# Telecommunication Systems

- Telecommunication technology consists of electromagnetic devices and systems for communicating over long distance.
- The purpose of any telecommunications system is to transfer information from the sender to the receiver by means of a communication channel. The information is carried by a signal, which is certain physical quantity that changes with time.
- Examples of telecommunications systems are the telephone network, the radio broadcasting system, computer networks and the Internet.

# History of Telecommunication

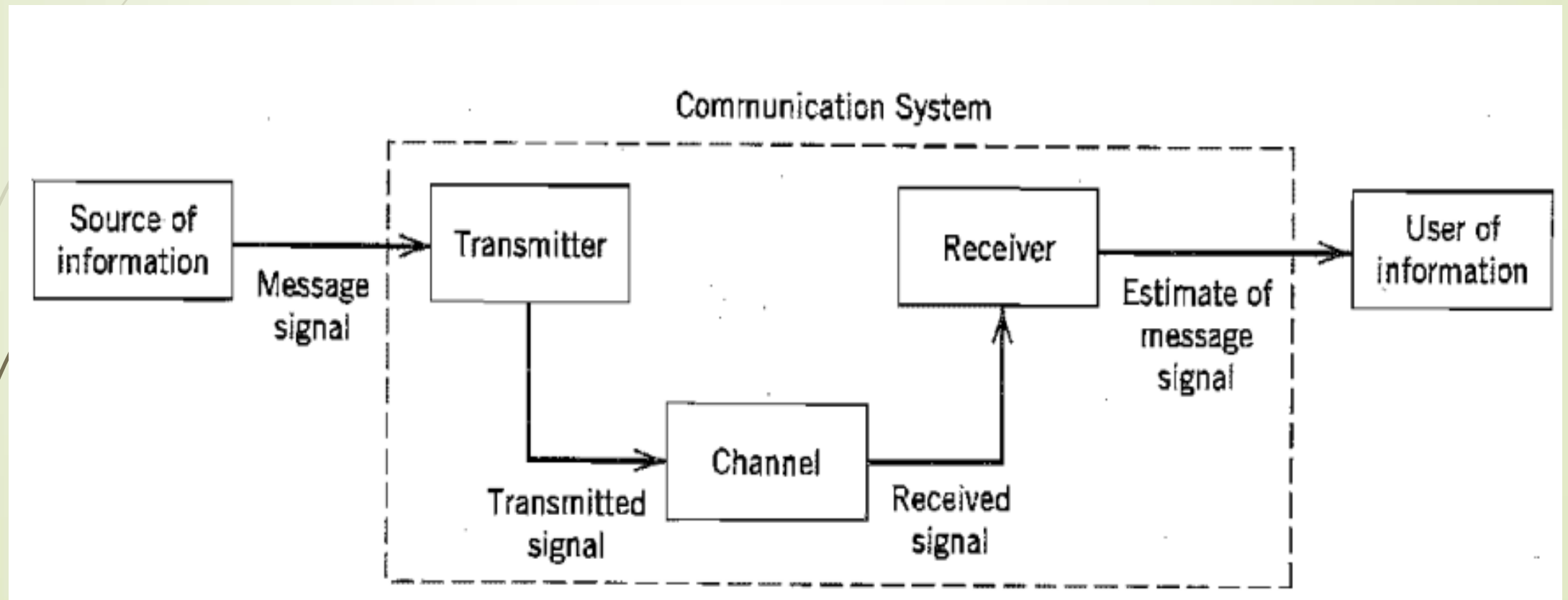
4

- One of the earliest inventions to communication was the invention of electric battery by Volta in 1799.
- This invention made it possible for Morse to develop the electric telegraph which he demonstrated in 1837.
- An important milestone in telegraphy was the installation of the first transatlantic cable in 1858 that linked Europe and US. That cable failed after about four weeks of operation.
- Telephony came into being with the invention of telephone in the 1870s.
- Alexander Graham Bell patented his invention of the telephone in 1876 and in 1877 established the Bell Telephone Company.
- Transcontinental telephone transmission became operational in 1915.
- In 1953 the first transatlantic cable was laid and telephone service became available between the US and Europe.

# History of Telecommunication

- The first automatic switch was developed by Strowger in 1897.
- With the invention of the transistor, electronic(digital) switching became economically feasible.
- At the Bell Telephone Laboratories, a digital switch was placed in service in Illinois in June 1960.
- During the past years there have been numerous significant advances in telecommunications.
- Fiber optic cables are rapidly replacing copper wires in the Telephone plant and electronic switches have replaced the old electromechanical systems.

# Elements of Communication System



# Elements of Communication System

## ➤ Transmitter:

- The transmitter converts the electrical signal into a form that is suitable for transmission through the physical channel or transmission medium.
- In general, the transmitter performs the matching of the message signal to the channel by a process called modulation.

## ➤ Channel:

- The communications channel is the physical medium that is used to send the signal from the transmitter to the receiver.
- In wireless transmission, the channel is usually the atmosphere (free space).

# Elements of Communication System

- Receiver:
  - The function of the receiver is to recover the message signal contained in the received signal.
  - If the message signal is transmitted by carrier modulation, the receiver performs carrier demodulation in order to extract the message from the sinusoidal carrier.
  - Besides performing the primary function of signal demodulation, the receiver also performs a number of peripheral functions, including signal filtering and noise suppression.



# Point-to-Point Communication

- In this mode of communication, the communication process takes place over a link between a single transmitter and receiver.
- In this case there is usually a bidirectional flow of information bearing signals, which requires the use of transmitter and receiver at each end of the link.

# Broadcast Communication

- ▶ Broadcast Communication involves the use of a single powerful transmitter and numerous receivers that are relatively inexpensive to build.
- ▶ Here information bearing signals flow in only one direction.
- ▶ Examples are telecommunication through radio broadcasts or Television.

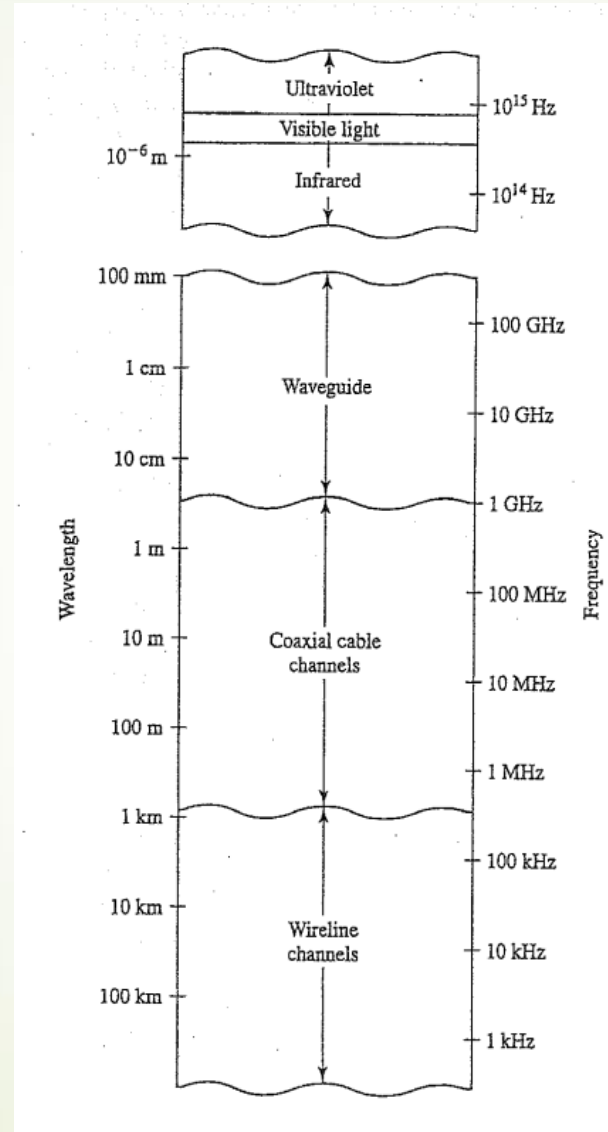
# Communication Channels and their Characteristics

- Wire line Channels
- Wireless Electromagnetic Channels

# Wire line Channels

- ▶ Twisted pair wire cable: Insulated pairs of wires historically used in telephone service and to connect computer devices.
- ▶ Coaxial cable
  - ▶ Consists of an inner conductor wire surrounded by insulation, called the dielectric.
  - ▶ The dielectric is surrounded by a conductive shield, which is surrounded by a non-conductive jacket. Coaxial cable has better data transmission rate than twisted pair.

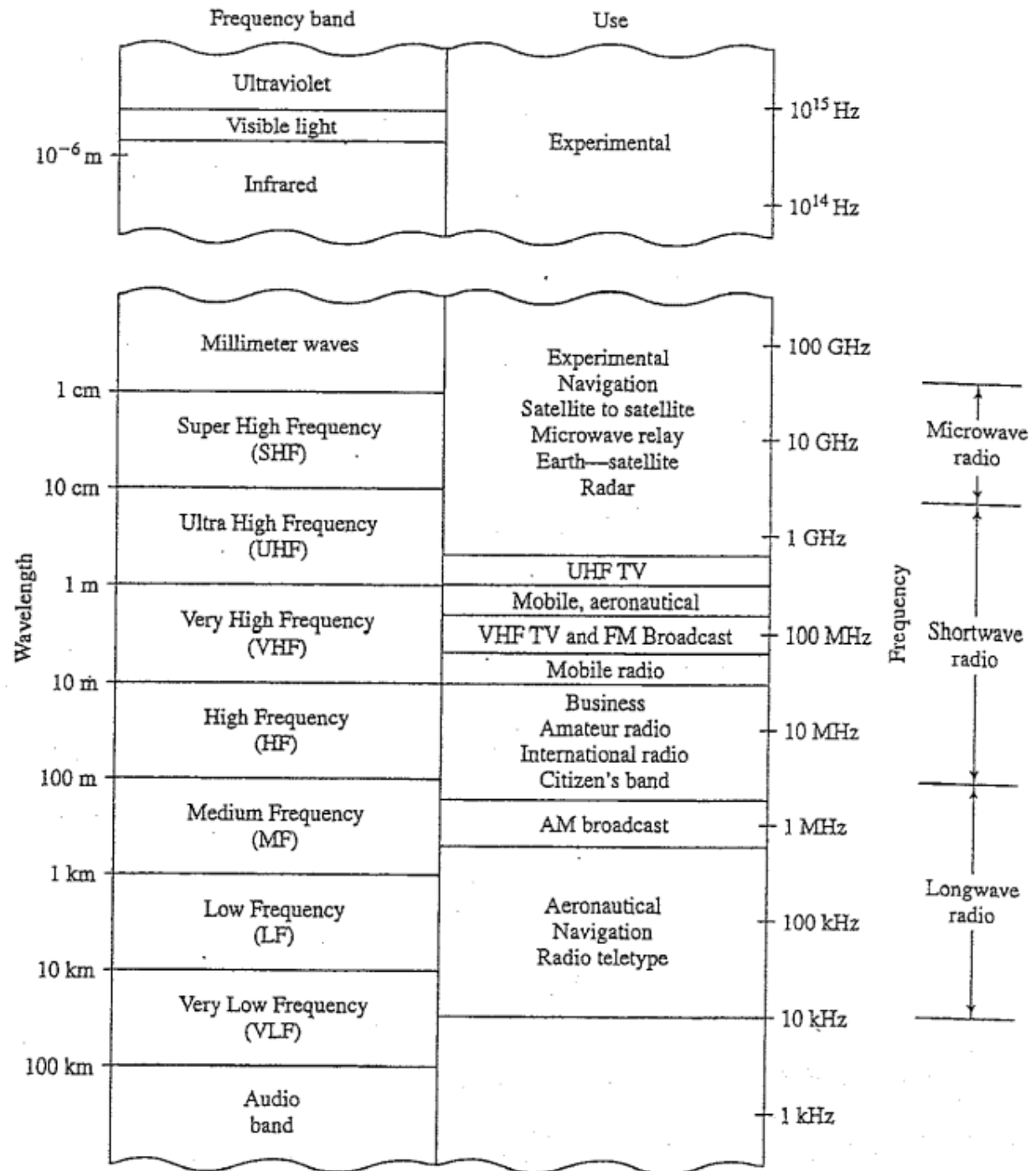
# Frequency Range for Guided Wireline Channels



# Wireless Channels

- Wireless communication is a type of communication that is performed and delivered wirelessly.
- In radio communication systems, electromagnetic energy is coupled to the propagation medium by an antenna which serves as the radiator.
- The physical size and the configuration of the antenna depend primarily on the frequency of operation.
- Figure illustrates the various frequency bands of the electromagnetic spectrum.

# Frequency Range for Wireless Electromagnetic Channels



# Microwave Communication

- ▶ A microwave is an electromagnetic wave with a very short wavelength, between .039 inches (1 millimeter) and 1 foot (30 centimeters).
- ▶ Their short wavelengths make microwaves ideal for use in radio and television broadcasting.
- ▶ They can transmit along a vast range of frequencies without causing signal interference or overlap.

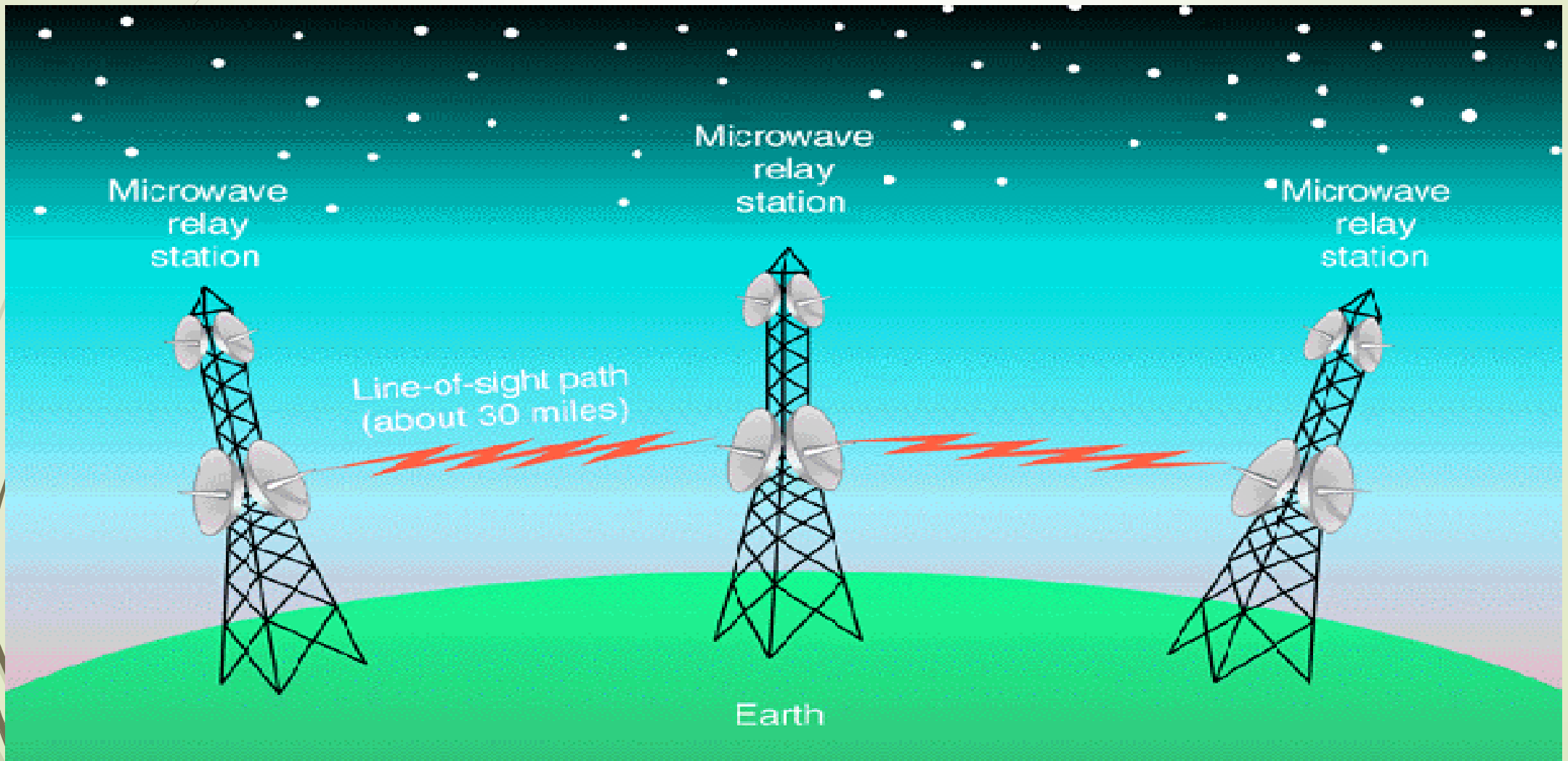


# Microwave Communication

- Microwaves can be easily broadcast and received via aerial antennas.
- The higher the antenna, the farther the signal can be broadcast. It takes many ground-based relay "hops" to carry a microwave signal across a continent.
- Raindrops and hailstones are similar in size to the wavelength of higher-frequency microwaves.
- Engineers can Use Microwaves to Track Weather using a process called microwave remote sensing.
- Figure next shows how microwave communication works.

# Microwave Communication

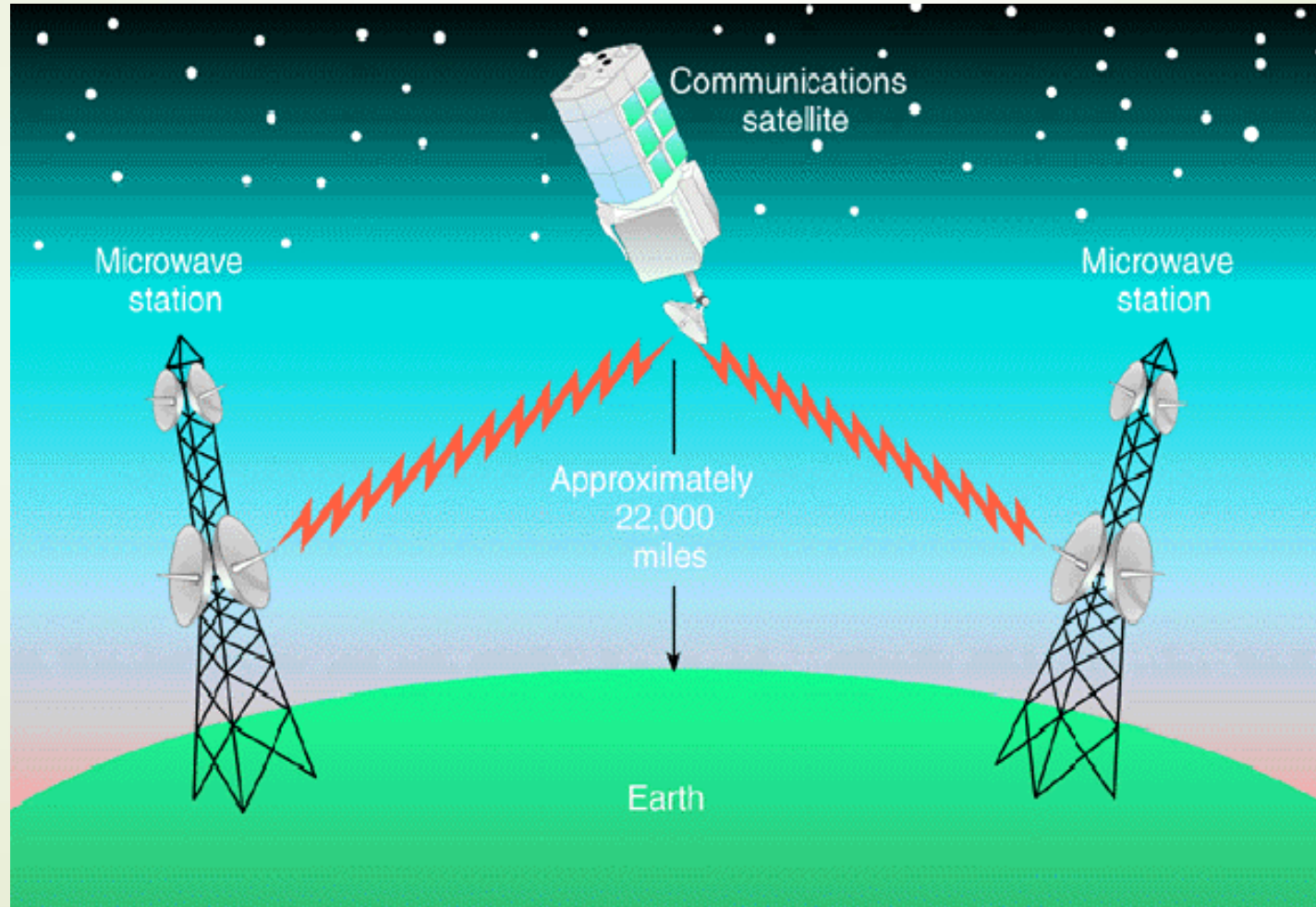
18



# Satellite Communication

- ▶ Satellite communication is the branch of telecommunication which establishes and communication using satellites across the globe.
- ▶ We can divide the whole satellite communication into two parts namely space segments and earth segment.
- ▶ A typical satellite link involves the transmission or up linking of a signal from an Earth station to a satellite.
- ▶ The satellite then receives and amplifies the signal and retransmits it back to Earth, where it is received and reamplified by Earth stations and terminals.
- ▶ Figure on next slide shows how satellite transmission works.

# Satellite Communication





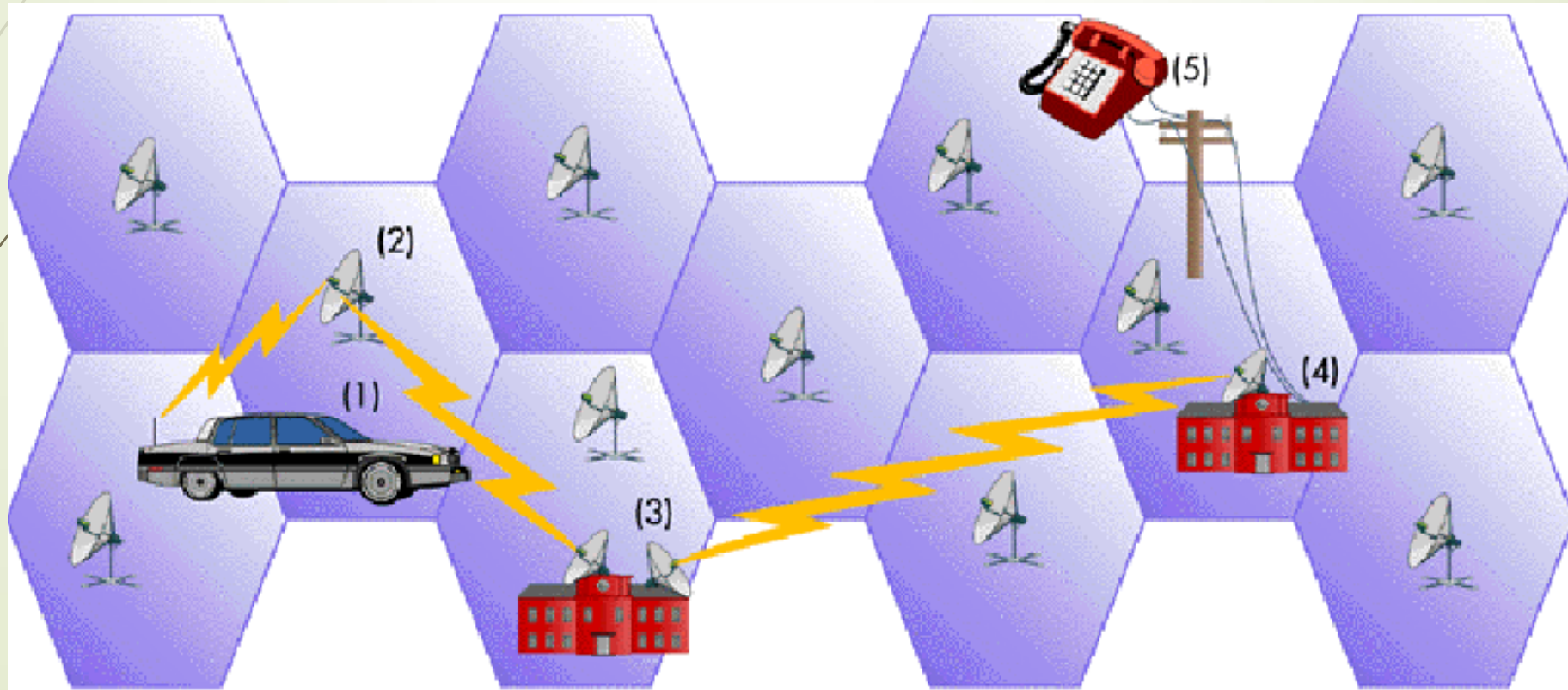
# Cellular Communication

- Cellular communication is a form of communication technology that enables the use of mobile phones.
- A mobile phone is a bidirectional radio that enables simultaneous transmission and reception.
- Cellular communication is based on the geographic division of the communication coverage area into cells, and within cells.
- Each cell is allocated a given number of frequencies (or channels) that allow a large number of subscribers to conduct conversations simultaneously.

# Cellular Communication

- Advance Mobile Phone Service (AMPS) is an example of analog mobile phone system.
- It is based on the initial electromagnetic radiation spectrum allocation for cellular service by the Federal Communications Commission (FCC) in 1970.
- For digital communications, several competing cellular systems exist, including GSM and CDMA.

# Cellular Communication

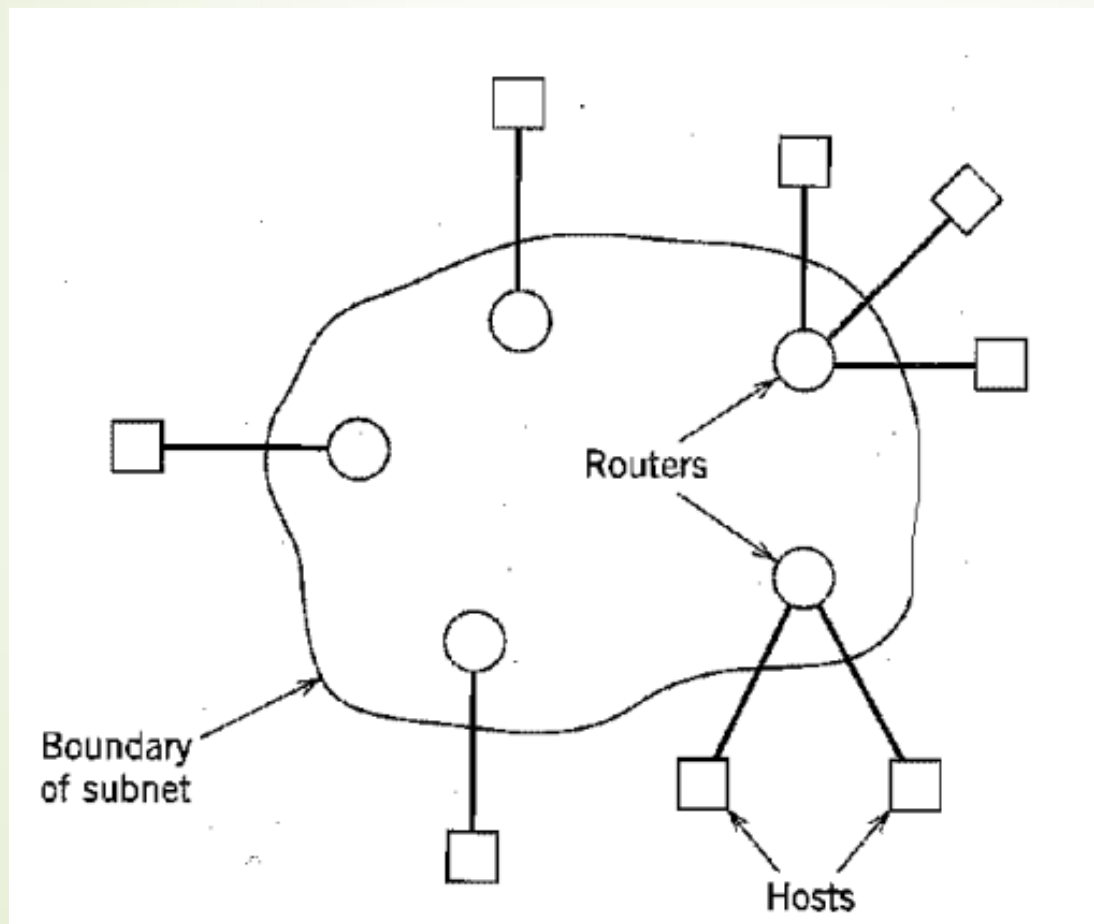


# Communication Networks

- A communication network or simply network consists of an inter connection of a number of routers.
- The primary purpose of these routers is to route data through the network.
- Each router has one or more hosts attached to it, hosts are devices that communicate with one another.
- The telephone network is an example of communication network in which circuit switching is used to provide a dedicated communication path between two hosts.



# Communication Networks



# Computer Network

- A computer network is a set of computers connected together for the purpose of sharing resources.
- Computers on the networks are called nodes.
- The computers are connected via cabling, most commonly the Ethernet cable or wirelessly through radio waves.
- The computer on a network can share resources like access to the internet, printers, files servers and others.

# The Internet

- Any discussion of computer networks naturally lead to the internet.
- The internet architecture has three functional blocks: hosts, subnets and router.
- The hosts constitute the nodes of the network, where data originate or where they are delivered.
- The routers constitute intermediate nodes that are used to cross subnet boundaries.
- Within a subnet, all the hosts belonging to that subnet exchange data directly.

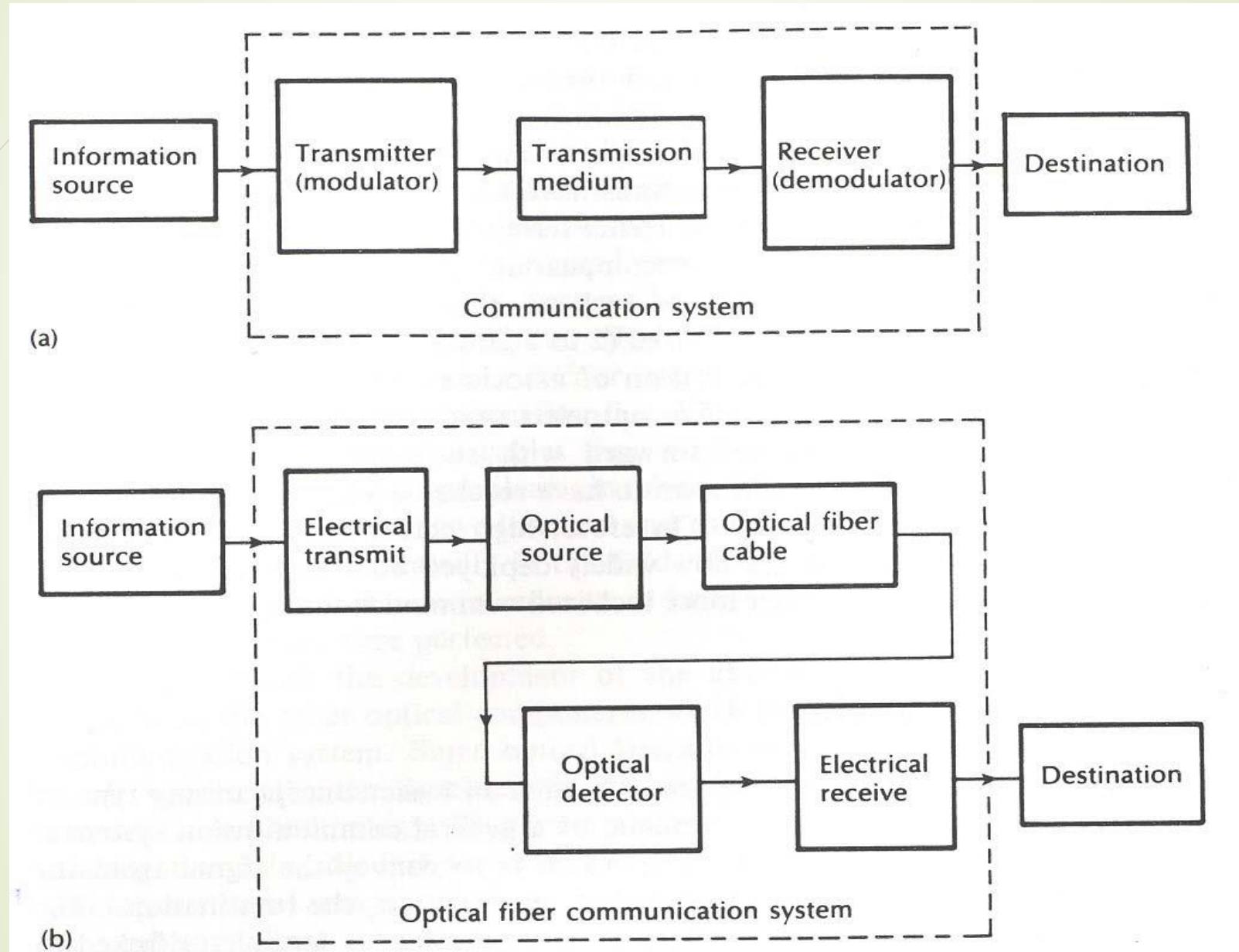
# Some Modern Telecommunication Systems

28

- Optical Communication systems
- Satellite Communication systems
- Cellular communication systems.
- Telecommunication systems for Aviation or Marine Applications
- Microwave Communication systems based on Waveguide technology
- VoIP Telephony based on H.323 and SIP platforms
- Spread Spectrum Communication and CDMA based systems
- TMN
- Multimedia Systems
- Broadcast Systems.
- Software defined Radio
- WiFi/Wimax/Bluetooth
- Wireless Sensor Networks.
- SCADA and Telemetry Systems

# Optical Communication Systems

29

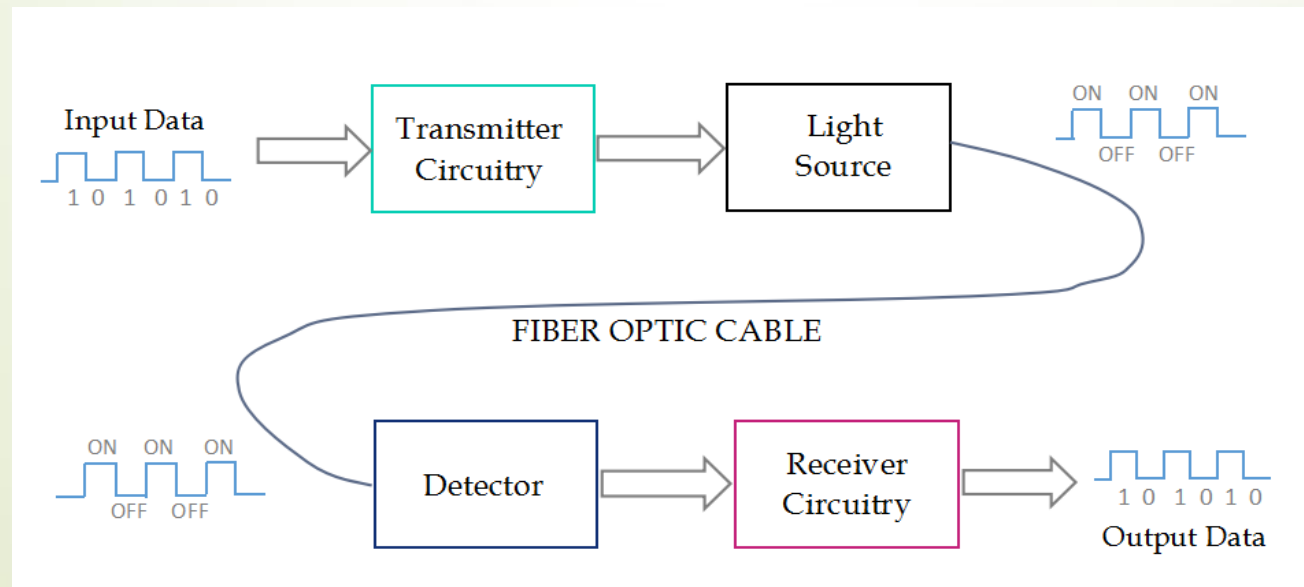


# Elements of Optical Communication System

30

## 3 Basic elements

- Light Source/Optical Source
- Optical Fiber
- Optical Detector



# Optical Source

- Depending on the applications like local area networks and the long haul communication systems, the light source requirements vary.
- The light emitting diodes are used for short distances and low data rate applications due to their low bandwidth and power capabilities.
- For longer distances and high data rate transmission, Laser Diodes are preferred due to its high power, high speeds.

# Fiber Optic Cable

- A fiber-optic cable is thin glass or plastic cable that acts as a light “pipe.”
- Fiber cables have a circular cross section with a diameter of only a fraction of an inch.
- A light source is placed at the end of the fiber, and light passes through it and exits at the other end of the cable.
- Light propagates through the fiber based upon the laws of optics.



# Fiber Optic Cable

33

- Benefits of fiber-optic cables over conventional electrical cables.

1. *Wider bandwidth.* Fiber-optic cables have high information-carrying capability.

2. *Low loss.* Fiber-optic cables have less signal attenuation over a given distance than an equivalent length of coaxial cable.

3. *Lightweight.* Glass or plastic cables are much lighter than copper cables and offer benefits when low weight is critical (e.g., aircraft).

4. *Small size.* Practical fiber-optic cables are much smaller in diameter than electrical cables and thus can be contained in a relatively small space.

5. *Security.* Fiber-optic cables cannot be as easily “tapped” as electrical cables, and they do not

radiate signals that can be picked up for eavesdropping purposes. There is less need for complex and expensive encryption techniques.

6. *Interference immunity.* Fiber-optic cables do not radiate signals, as some electrical cables do, and cause interference to other cables. They are immune to the picking up of interference from other sources.

7. *Greater safety.* Fiber-optic cables do not carry electricity. Therefore, there is no shock hazard. They are also insulators and thus not susceptible to lightning strikes as electrical cables are. They can be used in corrosive and/or explosive environments without danger of sparks.

# Photo Detector

- ▶ The purpose of photo detectors is to convert the light signal back to an electrical signal.
- ▶ Depending on the application's wavelengths, the material composition of these devices vary.



## Reference Books

- *Telecommunications* by Warren Hioki
- *Fiber-optic communication systems* by Govind P. Agrawal
- *Optical Fiber Communications* 3<sup>rd</sup> edition by Gerd Keiser