Course: Computer and Communication Networks

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

Topic: Data Communication and Networks

Presentation by

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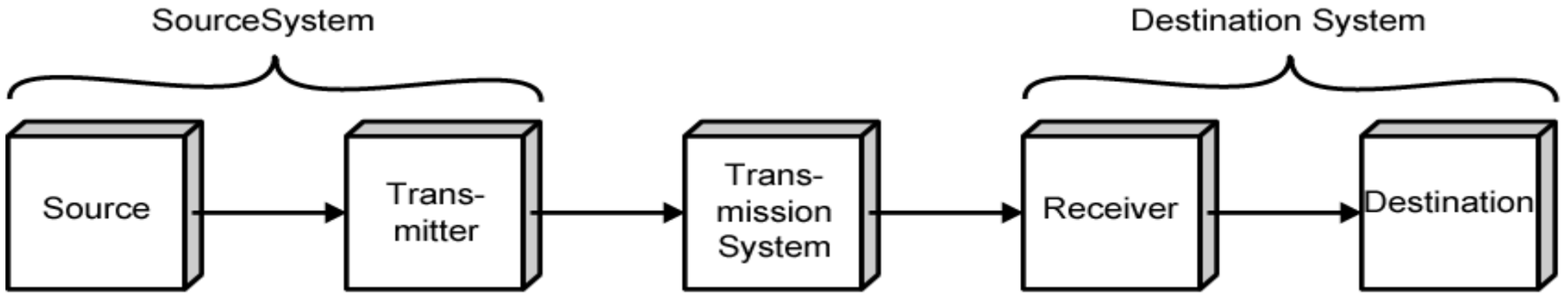
www.thapar.edu

Reference: 1. Ferouzan, Behrouz A., Data Communications and Networking, 2. Stallings William, Data and Computer Communication

Communications Model



(a) General block diagram

(b) Example

Reference: 1. Ferouzan, Behrouz A., Data Communications and Networking, 2. Stallings William, Data and Computer Communication

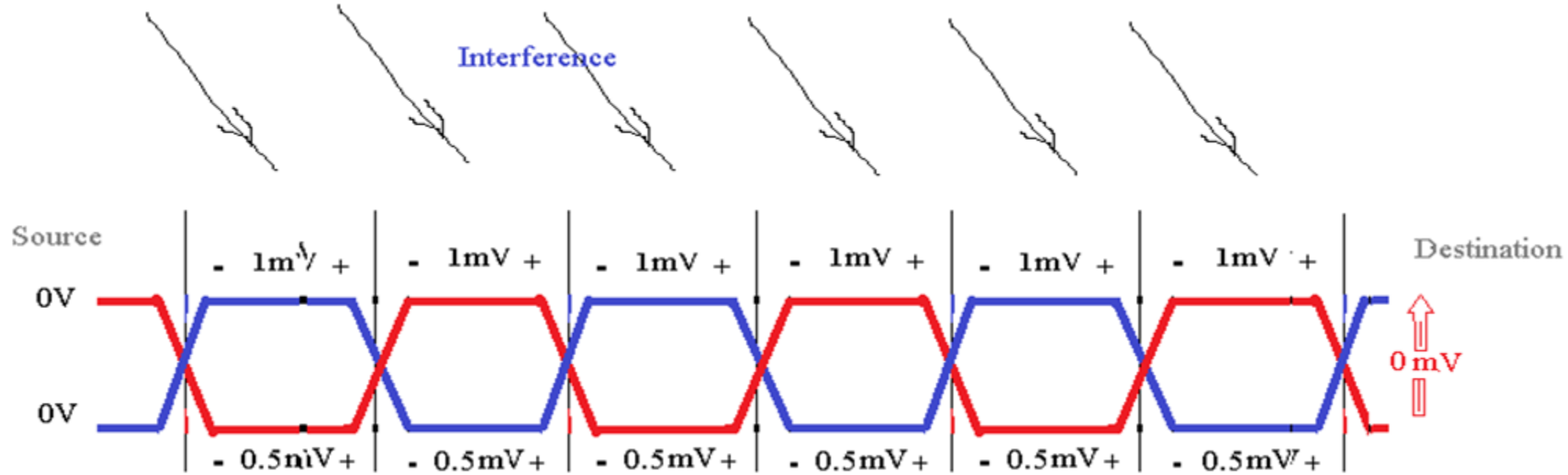
Communication Channel

- Types of connections of computers into networks: Physical versus Wireless connections
  - The first type: The Physical Connection.
    - Physically connect computers together.
      - Use of wires or optical cables.
      - The connections are called network links.
    - Three most common physical links:
      - Twisted pair
      - Coaxial cable
      - Fiber-optic cable

Reference: 1. Ferouzan, Behrouz A., Data Communications and Networking, 2. Stallings William, Data and Computer Communication

Communication Channel (Conta

- **Twisted pair**
  - Two wires twisted together.
    - Makes them less susceptible to acting like an antenna and picking up radio frequency information or appliance noise.
  - Telephone company uses twisted-pair copper wires to link telephones.



Reference: 1. Ferouzan, Behrouz A., Data Communications and Networking, 2. Stallings William, Data and Computer Communication

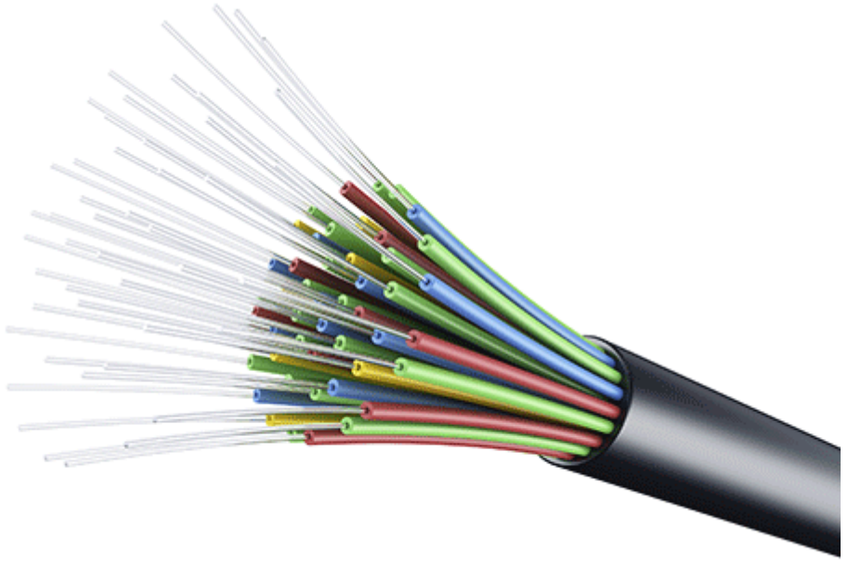
Communication Channel (Contd.)

- **Coaxial cable**
  - Also two wires:
    - One of the wires, which is woven of fine strands of copper forming a tube.
    - The wire mesh surrounds a solid copper wire that runs down the center.
    - Coaxial cable is a type of transmission line, which is used to carry high frequency electrical signals with low losses.

Reference: 1. Ferouzan, Behrouz A., Data Communications and Networking, 2. Stallings William, Data and Computer Communication

Communication Channel (Contd.)

- **Fiber-optic cable**
  - *It* is a method of transmitting information from one place to another by sending pulses of infrared light through an *optical fiber*.
  - Can transmit more information down a single strand.
  - Each cable can send several thousand phone conversations or computer communications.



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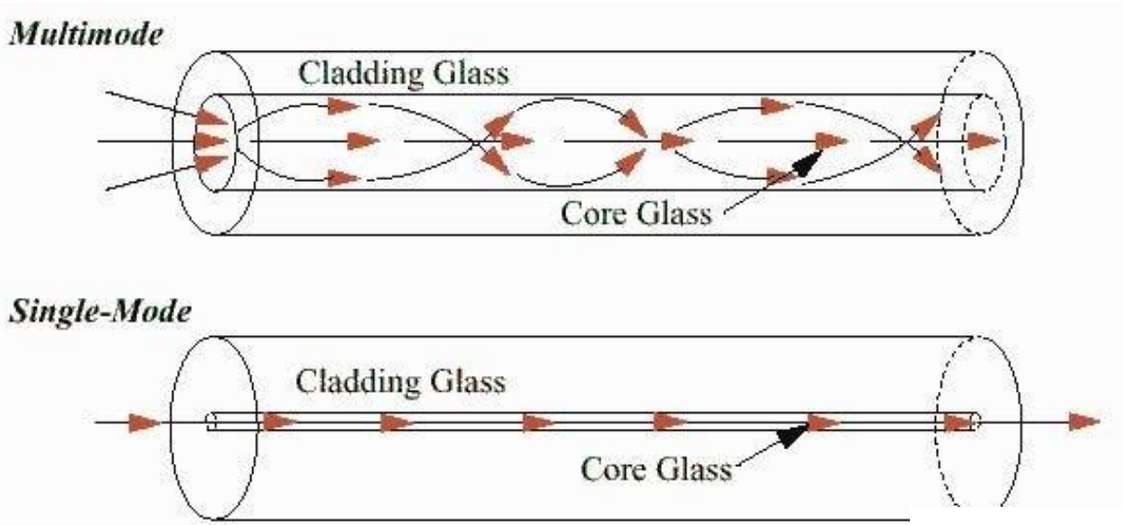
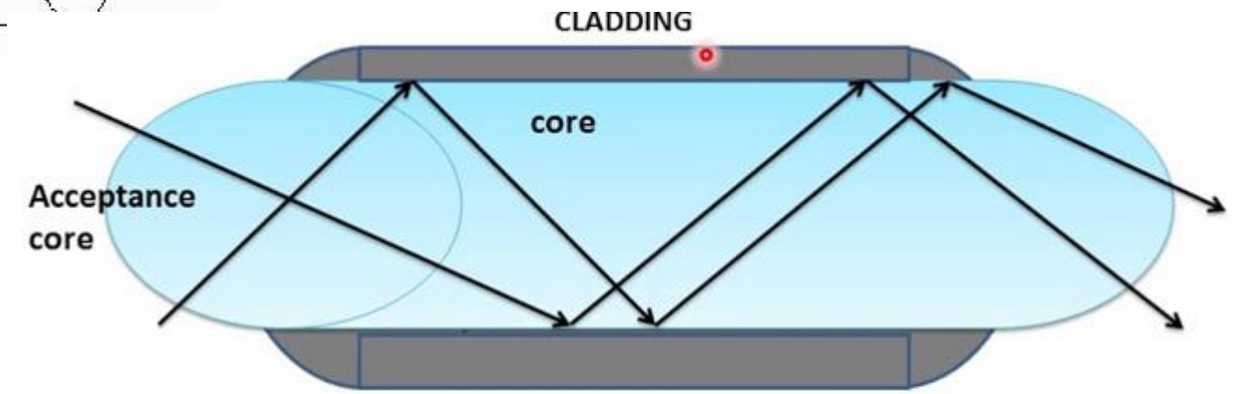
Communication Channel (Contd.)





Acceptance angle give equation $i_o = \sin^{-1}\sqrt{n_1^2 - n_2^2}$

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Communication Channel (Contd.)

- Second type of connections of computers into networks: Wireless connections
  - The link is made using electromagnetic energy that goes through space instead of along wires or cables.
  - Three types of wireless communications commonly used in networking:
    - Infrared
    - Radio frequency
    - Microwave

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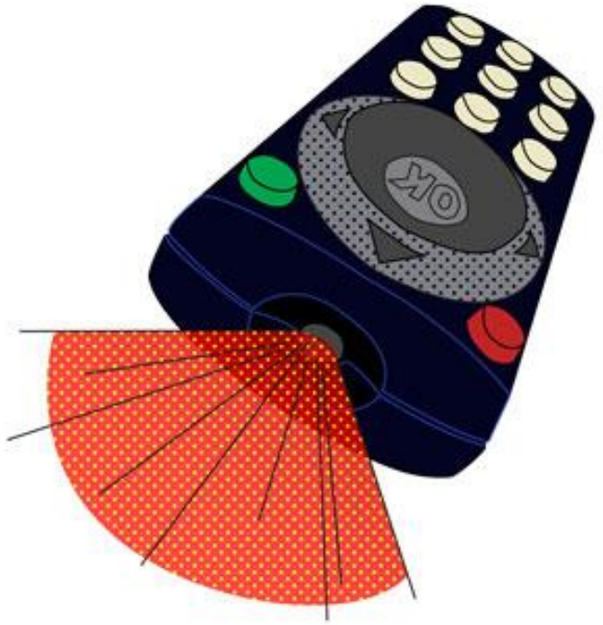
Communication Channel (Contd.)

- **Infrared**
  - Commonly used in TV remote controls.
  - Use infrared frequencies of electromagnetic radiation that behave much like visible light.
  - Must be in the line of sight.
  - Often used to connect keyboards with printers.



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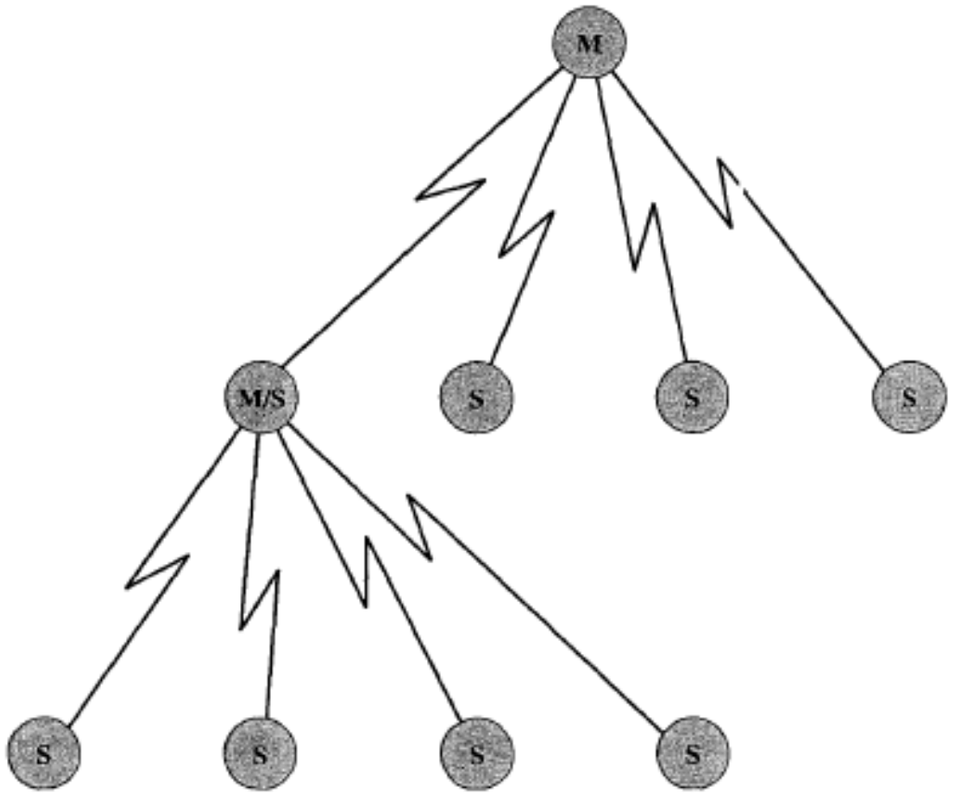
Communication Channel (Contd.)

- **Bluetooth**
- Make calls from a wireless headset connected remotely to a cell phone.
- Eliminate cables linking computers to printers, keyboards, and the mouse.
- Hook up MP3 players wirelessly to other machines t download music.
- From a remote location to turn appliances on and off, set the alarm, and monitor activity.



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Communication Channel (Contd.)

- **Radio frequency**
  - Uses radio frequencies.
    - Function even though line of sight is interrupted.
  - Not commonly used because of the possible interference from other sources of electromagnetic radiation such as old electric drills and furnace motors.

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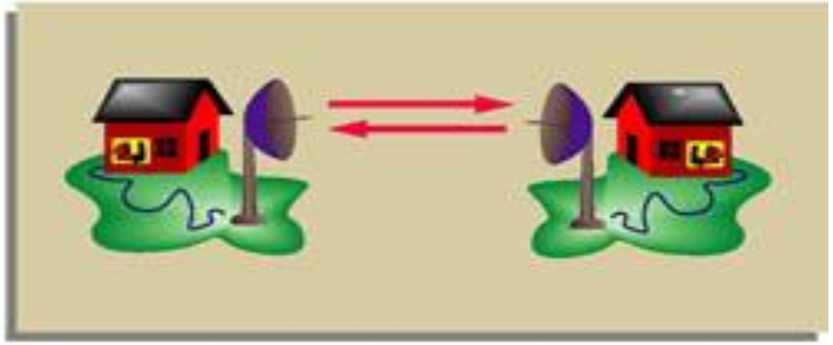
Communication Channel (Contd.)

- **Microwave**
  - Often used to communicate with distant locations.
  - Must be line of sight.
  - Satellite communications use microwaves.



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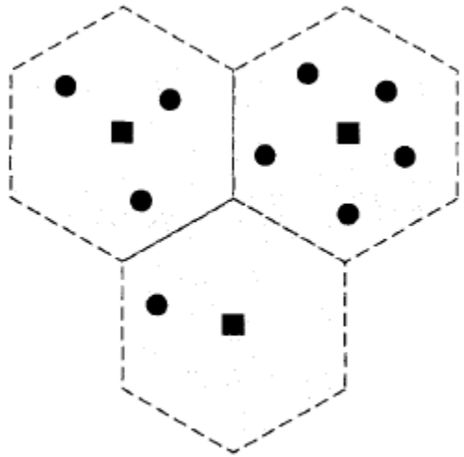
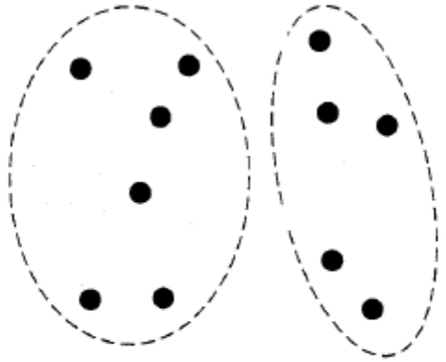
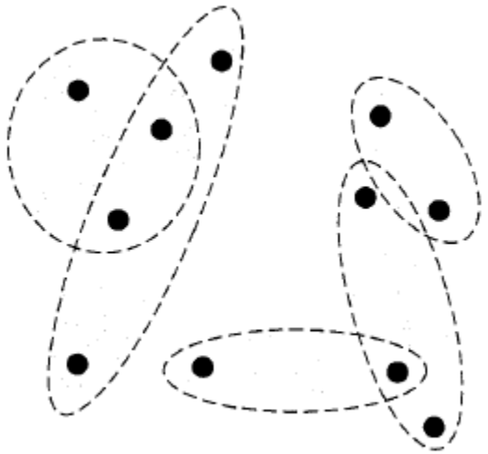
Communication Channel (Contd.)



(a) Cellular system (squares represent stationary base stations)



(b) Conventional ad hoc systems



(c) Scatternets

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Communication Basics

The speed at which the signal is transmitted (how fast the data travels).

- In digital systems: Speed is measured in...
  - **Bits per second** (bps).
    - The number of bits (0's and 1's) that travel down the channel per second.
  - **Baud rate**
    - The number of bits that travel down the channel in a given interval.
    - The number is given in signal changes per second, not necessarily bits per second.

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Network Criteria

- Performance – depends on number of users, type of medium, HW/SW
- Reliability – measured by freq of failure, recovery time, catastrophe vulnerability
- Security – protection from unauthorized access, viruses/worms

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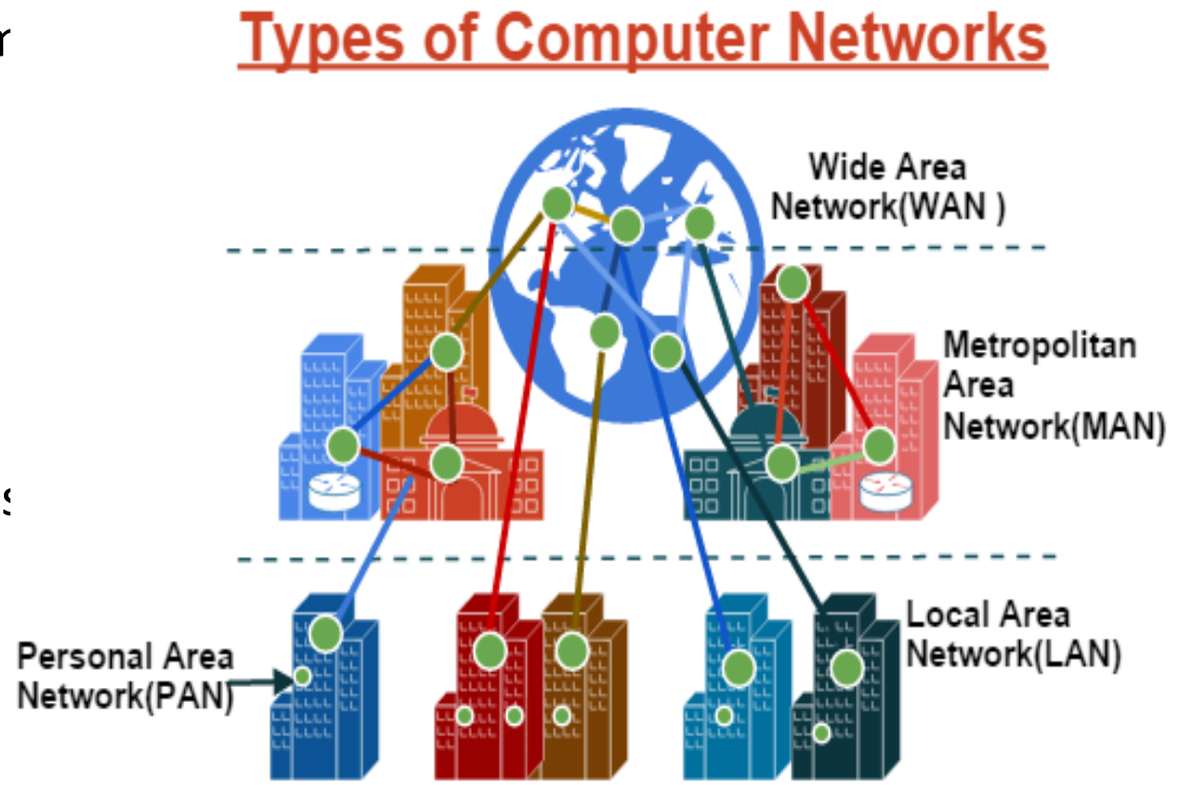
Network coverage

- Local Area Networks:
  - Used for small networks (school, hom office)
  - Examples and configurations:
    - Wireless LAN or Switched LAN
    - ATM LAN, Frame Ethernet LAN
- Metropolitan Area Network
  - Backbone network connecting all LANs
  - Can cover a city or the entire country
- Wide Area Network
  - Typically between cities and countries
  - Technology:
    - Circuit Switch, Packet Switch, Frame Relay, ATM



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Channel /Transmission Impairments

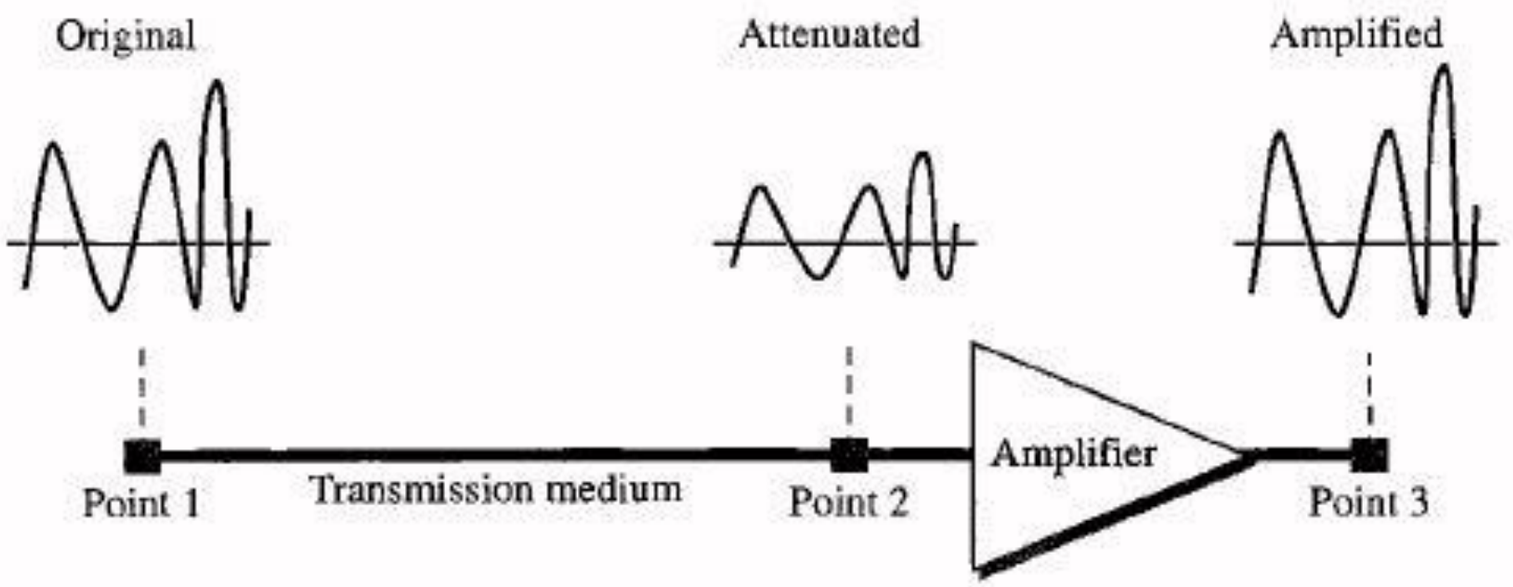
• **Attenuation and attenuation distortion**

a) A received signal must have sufficient strength so that the electronic circuitry in the receiver can detect the signal.

b) The signal must maintain a level sufficiently higher than noise to be received without error.

c) Attenuation varies with frequency.

Use repeaters



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Channel /Transmission Impairments

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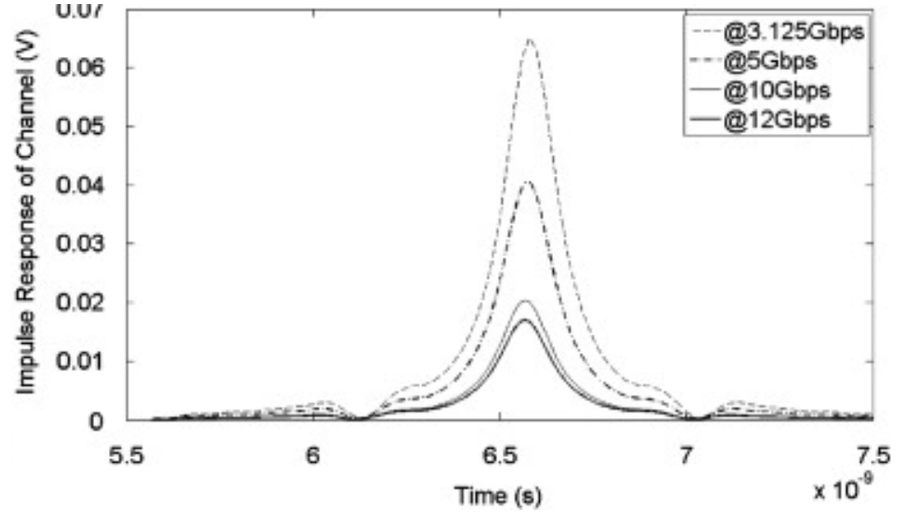
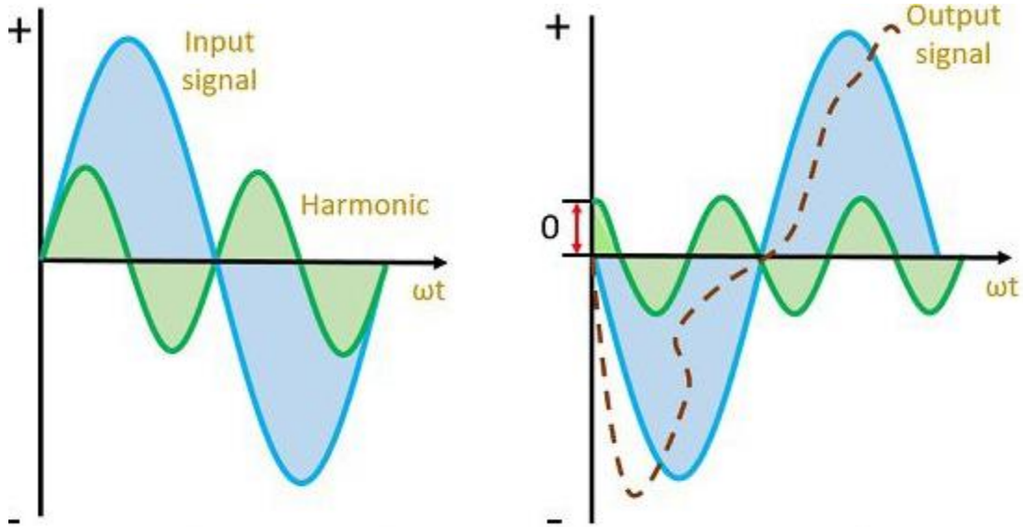
- **Delay distortion**

a) Delay distortion occurs because the velocity of propagation of a signal through a guided medium varies with frequency.

b) The velocity tends to be **highest near the center frequency** and **fall off toward the two edges of the band**.
Solution: filtering

c) It can leads to **Intersymbol** interference, where some of the signal components of one bit position will spill over into other bit positions
Solution: adaptive equalization and error correcting codes





Phase Distortion due to delay

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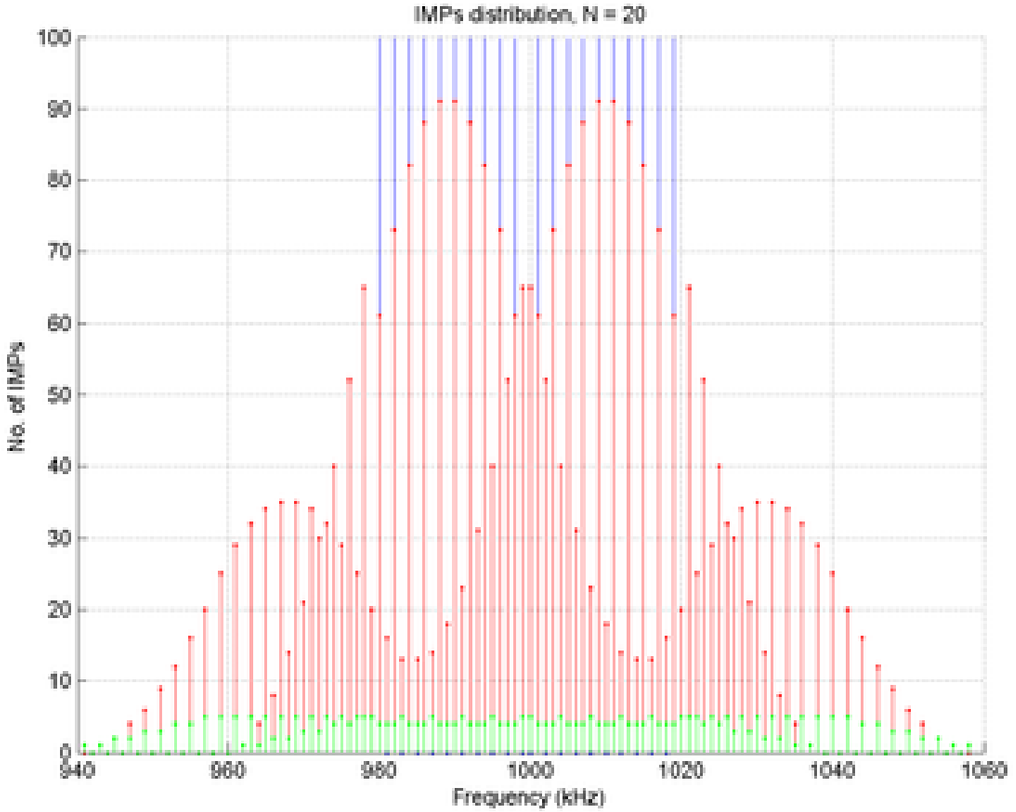
Channel /Transmission Impairments

- **Noise**

Thermal noise: Thermal noise is due to thermal agitation of electrons.

Solution: lowering temperature and resistance if possible

Intermodulation noise: When signals at different frequencies share the same transmission medium, the result may be intermodulation noise.



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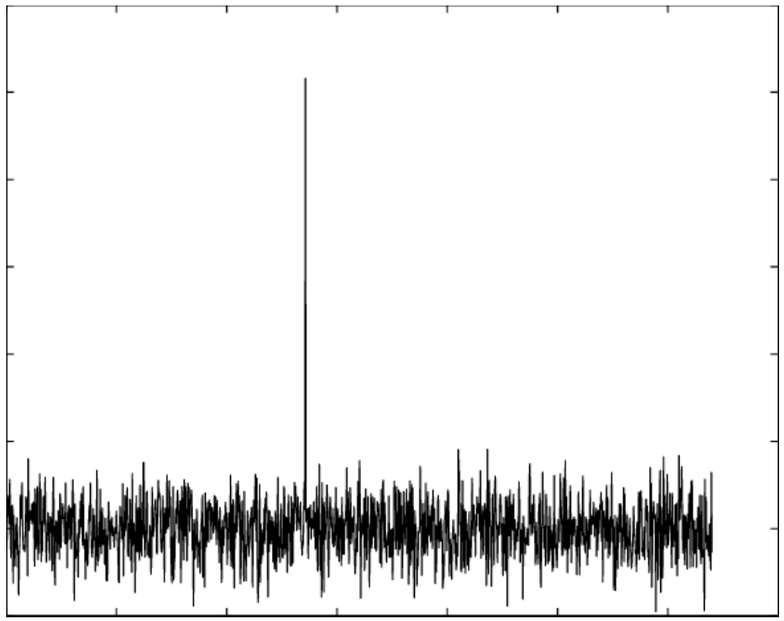
Channel /Transmission Impairments

- **Noise**

Crosstalk: it is an unwanted coupling between signal paths.

Impulse noise: is noncontinuous, consisting of irregular pulses or noise spikes of short duration and of relatively high amplitude.



Effect of Noise on Digital Signal

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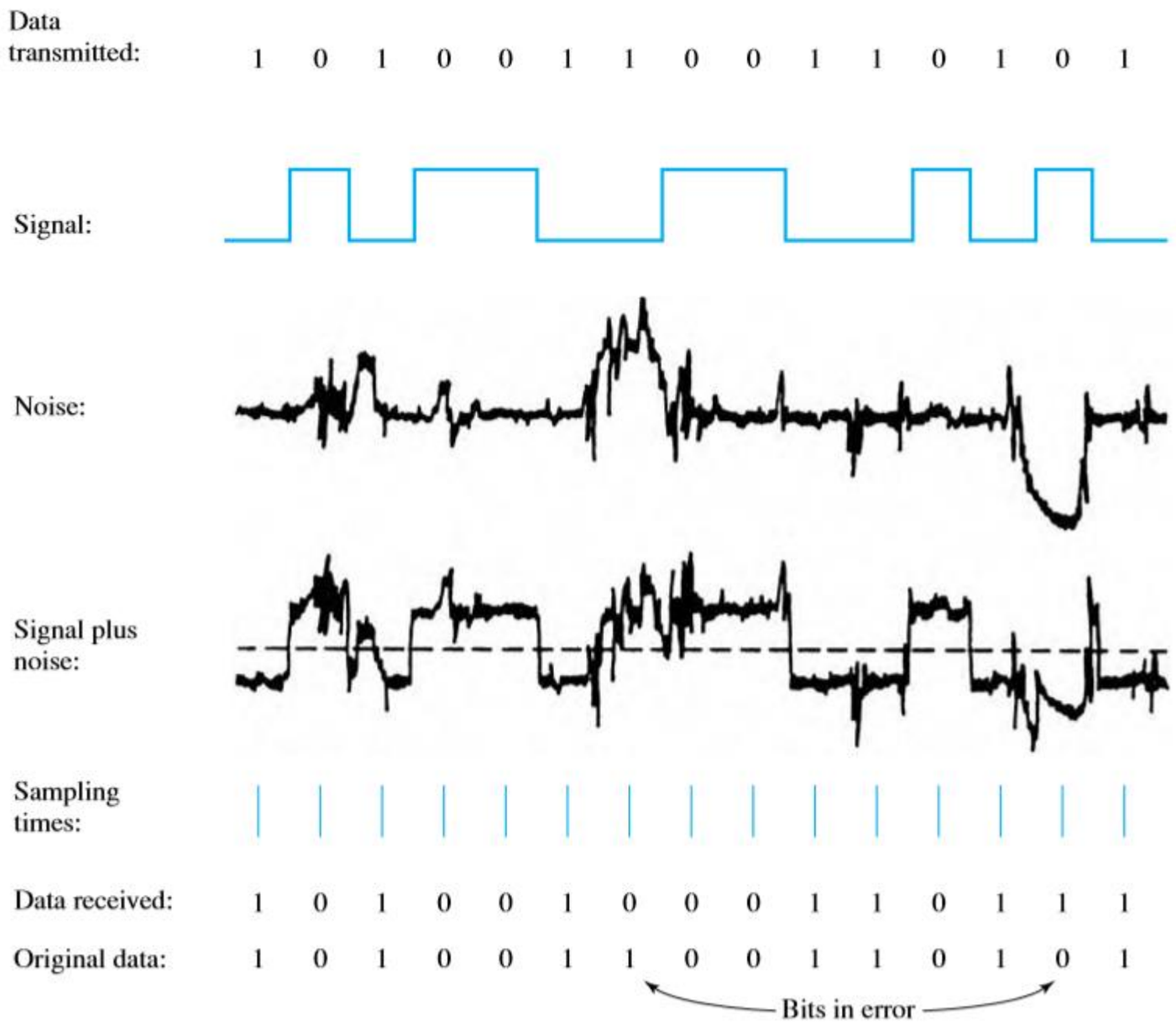

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Nyquist and Shannon Capacity formula

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$$C = 2B \log_2 M$$

Shannon Capacity Formula

$$C = B \log_2(1 + \text{SNR})$$

$$\text{SNR}_{\text{dB}} = 10 \log_{10} \frac{\text{signal power}}{\text{noise power}}$$

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Nyquist and Shannon Capacity formula

Television channels are 6 MHz wide. How many bits/sec can be sent if four-level digital signals are used? Assume a noiseless channel.

Bandwidth = 6 MHz (given) = 6×10^6

Using Nyquist's Theorem,

$$C = 2B \log_2 M$$

$$C = 2 \times 6 \times 10^6 \times \log_2 4$$

$$C = 24 \text{ Mbps}$$

Hence, C = 24 Mbps

Consider an extremely noisy channel in which the value of the signal-to-noise ratio is almost zero. In other words, the noise is so strong that the signal is faint. For this channel the capacity C is calculated as

C=B log2 (1 + SNR)
=B log2 (1 + 0)
=B log2 (1)
=0

Thank You