COMPUTER NETWORKS

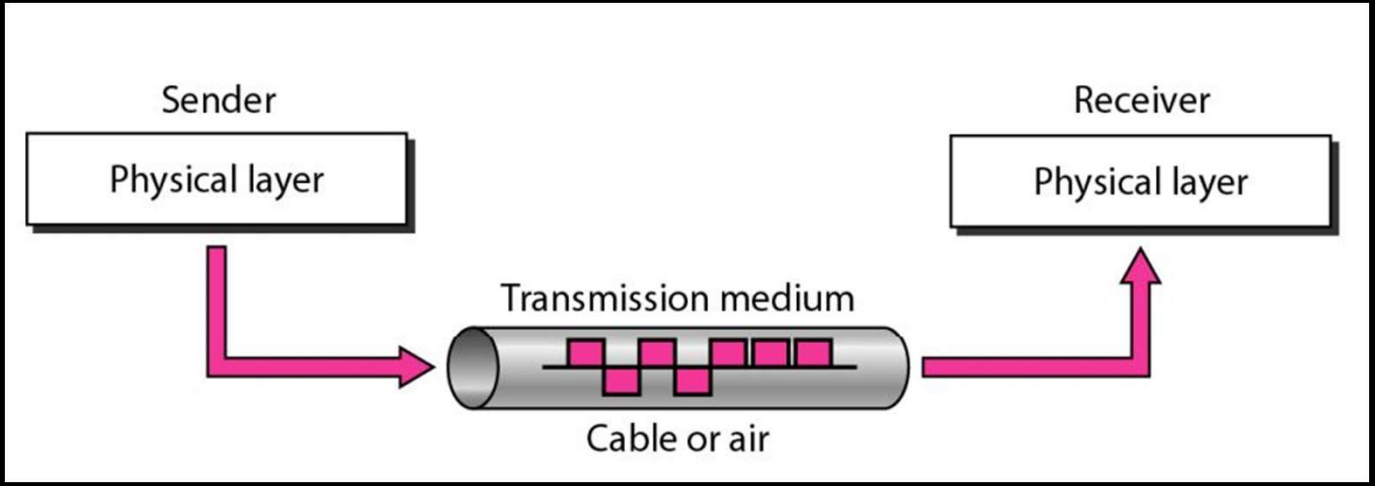
Unit-I

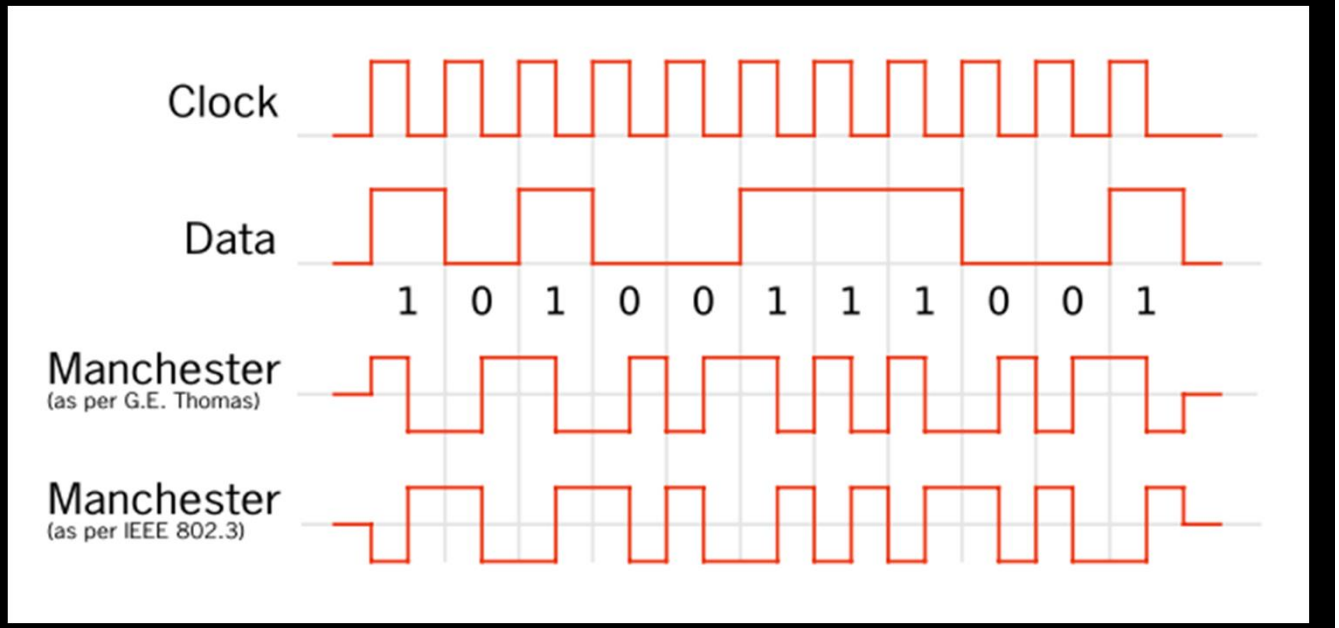
Unit-I (Physical Layer)

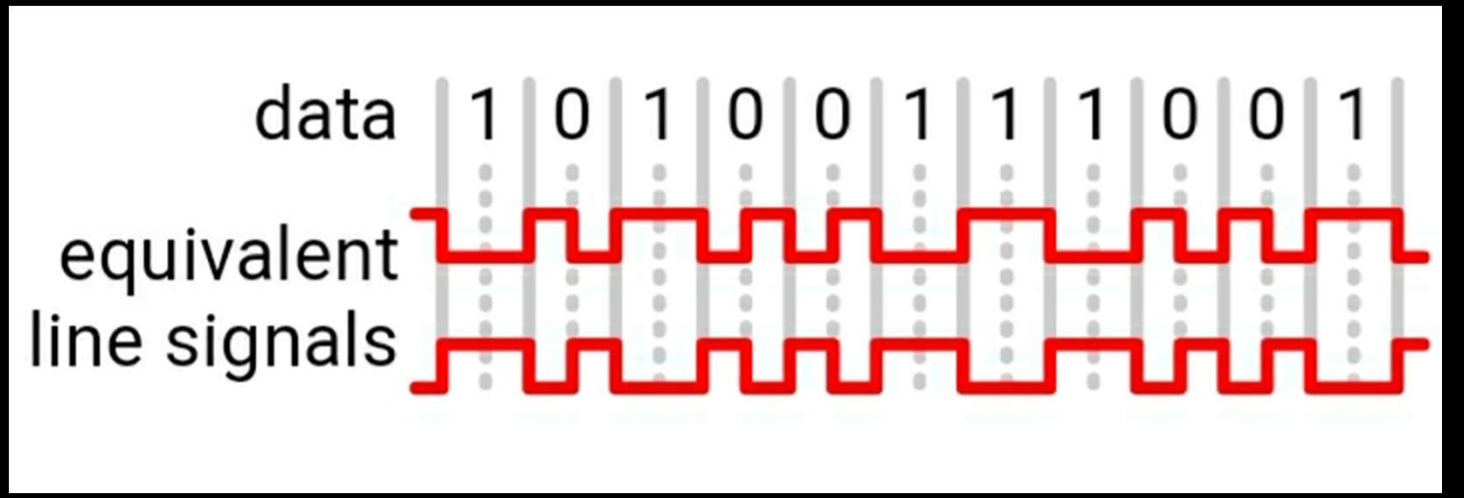
- Guided Transmission media
  - Twisted pairs
  - Coaxial cable
  - Fiber optics
- Wireless transmission.

Physical Layer

- The purpose of the physical layer is to transport bits from one machine to another.
- Various physical media can be used for the actual transmission.
- Each one has its own niche in terms of bandwidth, delay, cost, and ease of installation and maintenance.



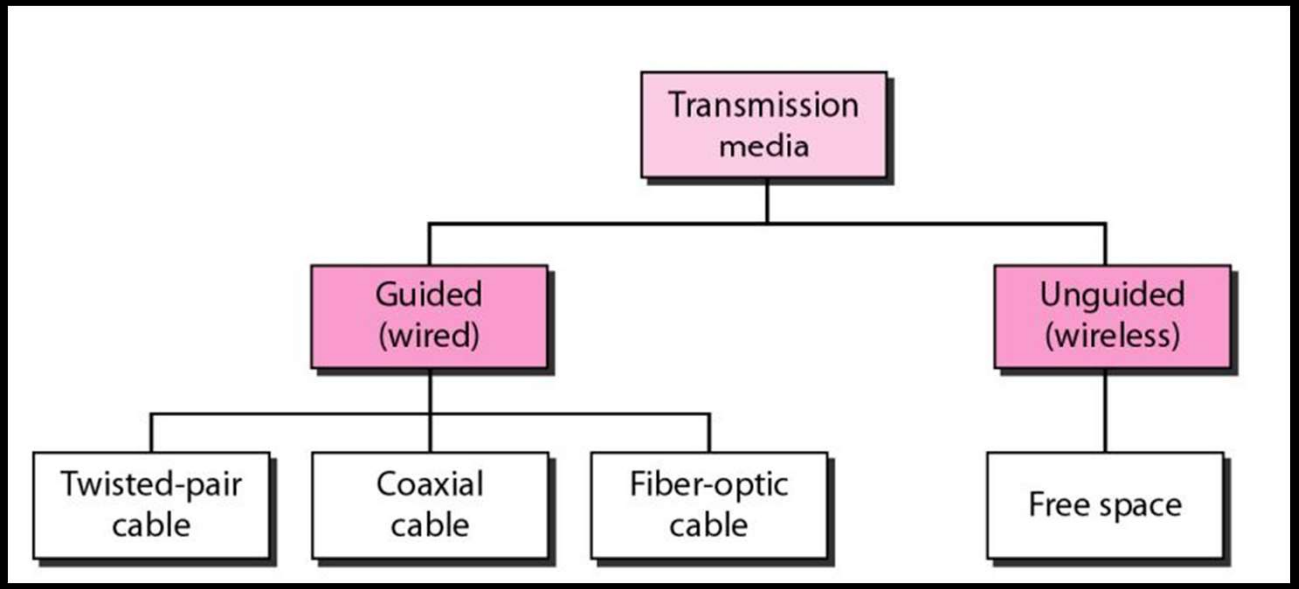

Clock
Data
1 0 1 0 0 1 1 1 0 0 1
Manchester
(as per G.E. Thomas)
Manchester
(as per IEEE 802.3)



Differential Manchester Encoding

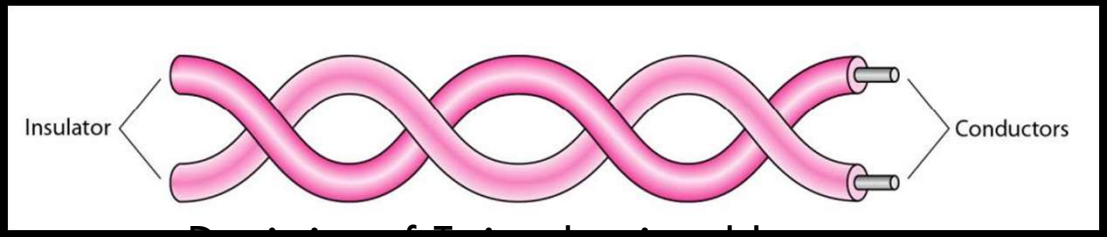
Transmission Media

- Media are roughly grouped into
  - Guided media, such as
    - copper wire and fiber optics, and
  - Unguided media, such as
    - terrestrial wireless, satellite, and lasers through the air.



Twisted Pairs

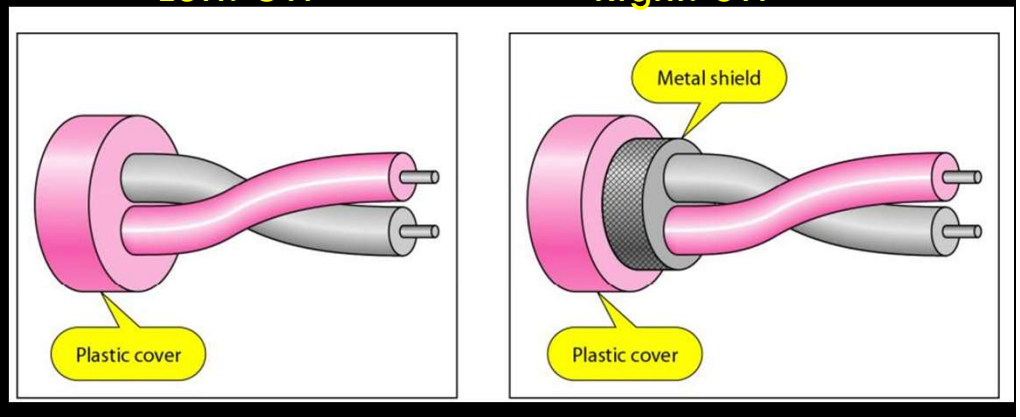
- One of the oldest and still most common transmission media is twisted pair.
- A twisted pair consists of two insulated copper wires, typically about 1 mm thick.
- The wires are twisted together in a helical form, just like a DNA molecule.
- Twisting is done because two parallel wires constitute a fine antenna.
- When the wires are twisted, the waves from different twists cancel out, so the wire radiates less effectively.
- A signal is usually carried as the difference in voltage between the two wires in the pair.
- This provides better immunity to external noise because the noise tends to affect both wires the same, leaving the differential unchanged.

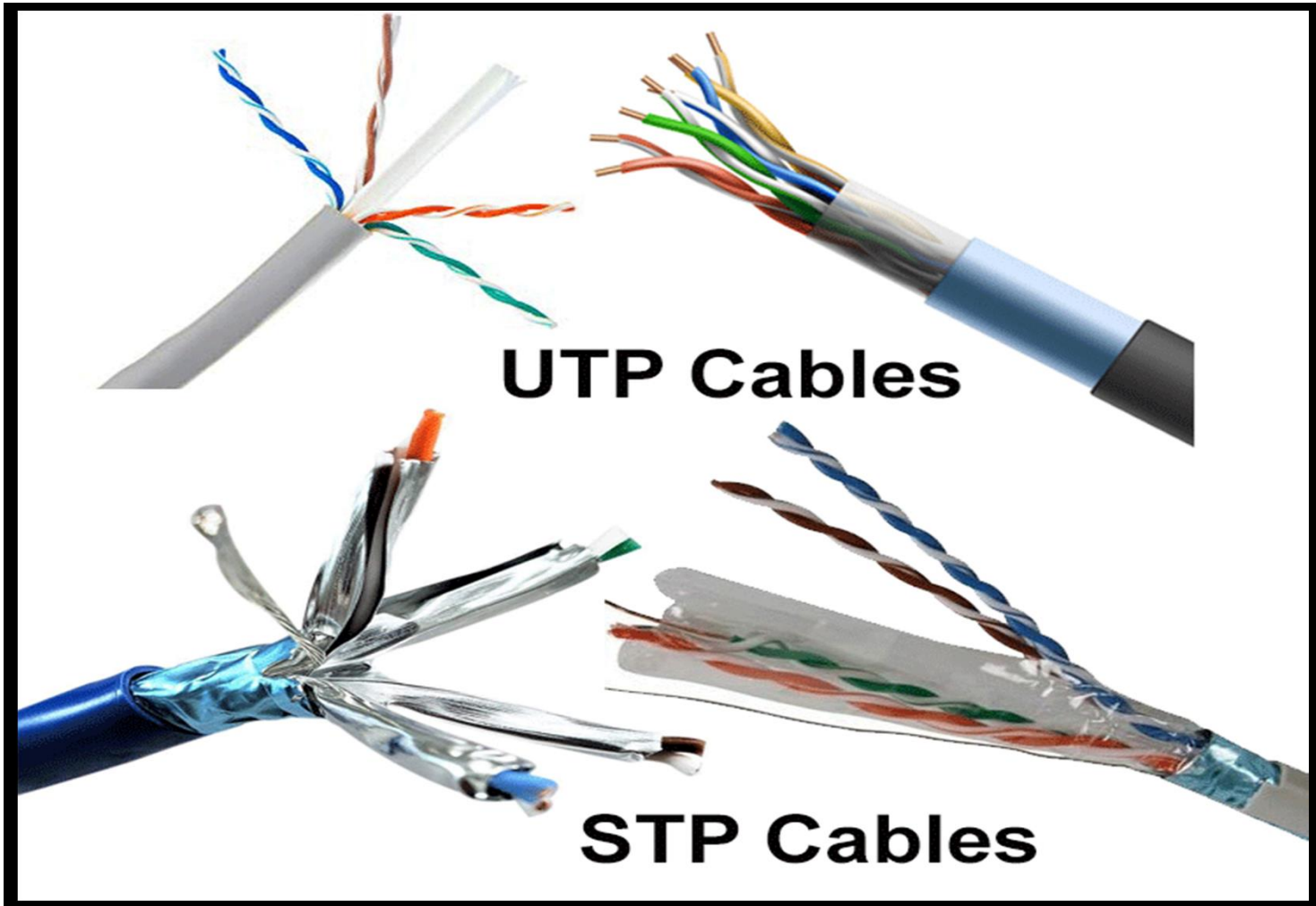


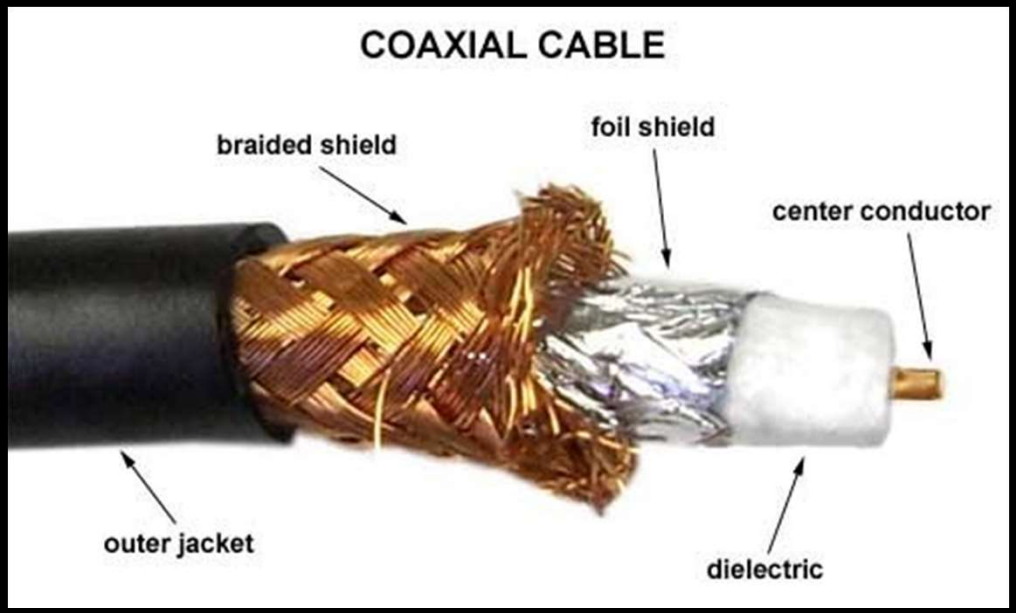
Types of Twisted pair cable

- Twisted pairs can be used for transmitting either analog or digital information
- Category 1 to Category 6, are referred to as UTP (Unshielded Twisted Pair) as they consist simply of wires and insulators.
- Category 7 cables have shielding on the individual twisted pairs, as well as around the entire cable (but inside the plastic protective sheath).
- Shielding reduces the susceptibility to external interference and crosstalk with other nearby cables to meet demanding performance specifications.

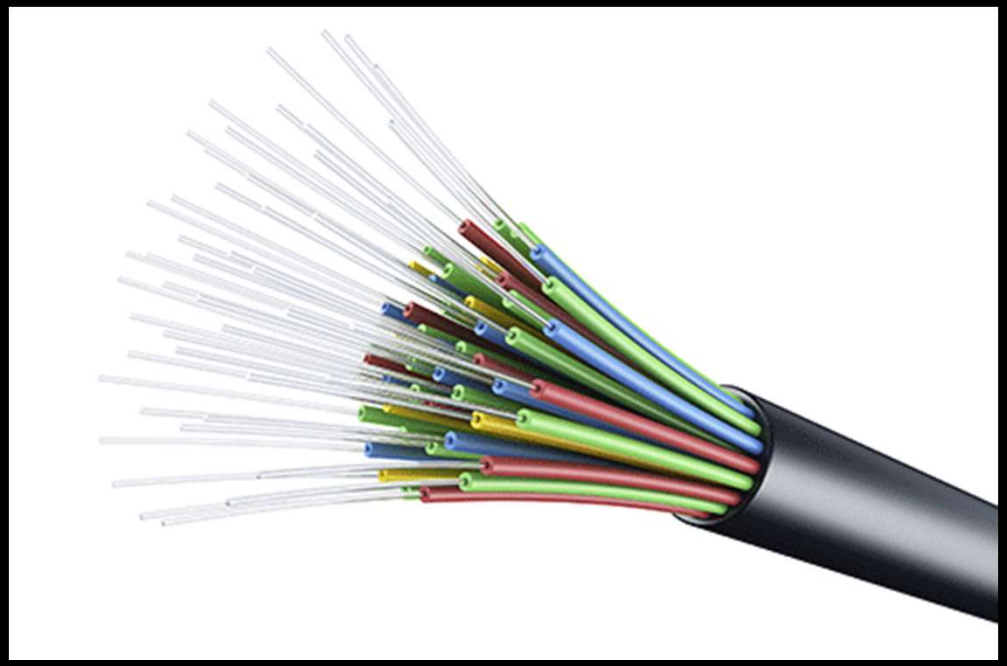
Left: UTP Right: STP



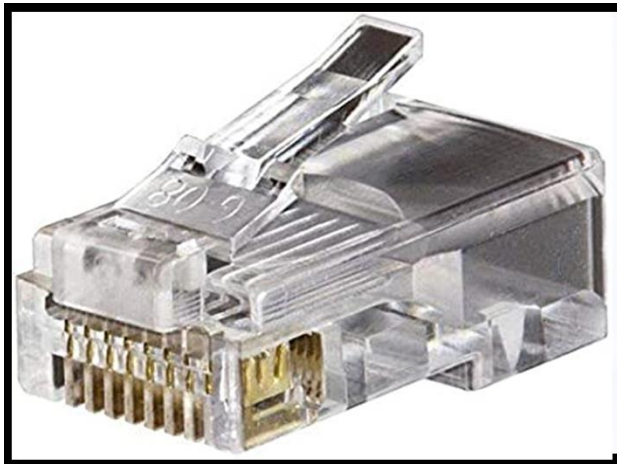

UTP Cables
STP Cables


COAXIAL CABLE
braided shield
foil shield
center conductor
outer jacket
dielectric


RG-58 C/U
RG-59 B/U
RG-62 A/U
RG-6/U
RG-11/U




WIFI
300M Wireless USB Adapter

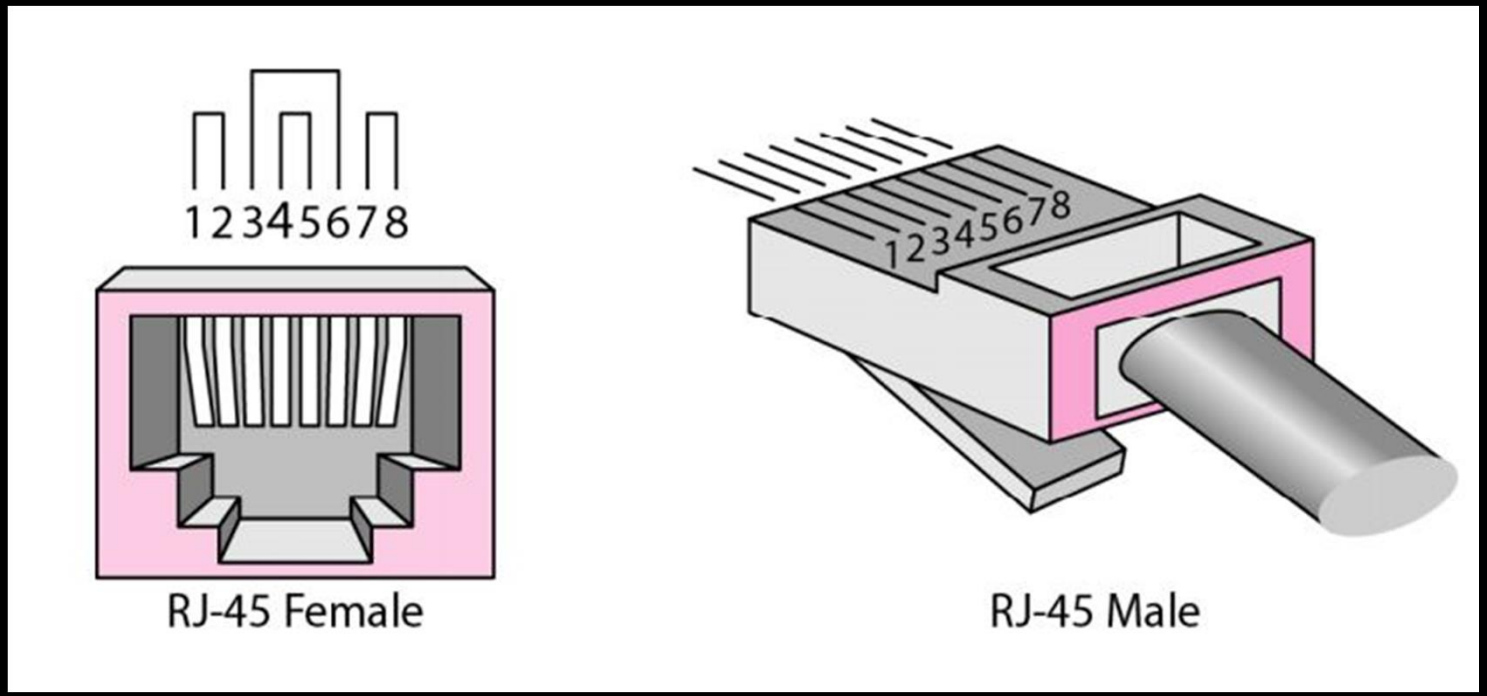



FOT
T-ST
T-SC
T-SC-Duplex
T-SC/APC-8°/9°
FDDI/MIC
ESCON
F-SMA
MT-RJ (male)
MT-RJ (female)
LC
LC-Duplex
FC/PC
PC/APC
DIN
E-2000
E-2000/APC
www.fiberoptictel.com

Categories of Twisted pair cable

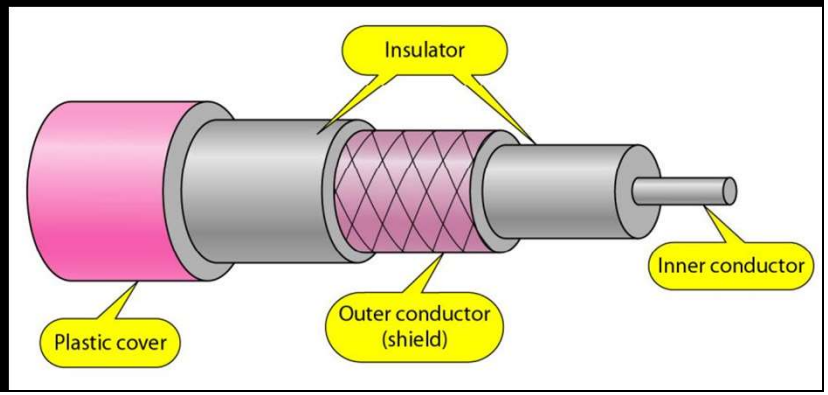
Category	*Specification*	*Data Rate (Mbps)*	*Use*
1	Unshielded twisted-pair used in telephone	< 0.1	Telephone
2	Unshielded twisted-pair originally used in T-lines	2	T-1 lines
3	Improved CAT 2 used in LANs	10	LANs
4	Improved CAT 3 used in Token Ring networks	20	LANs
5	Cable wire is normally 24 AWG with a jacket and outside sheath	100	LANs
5E	An extension to category 5 that includes extra features to minimize the crosstalk and electromagnetic interference	125	LANs
6	A new category with matched components coming from the same manufacturer. The cable must be tested at a 200-Mbps data rate.	200	LANs
7	Sometimes called SSTP (shielded screen twisted-pair). Each pair is individually wrapped in a helical metallic foil followed by a metallic foil shield in addition to the outside sheath. The shield decreases the effect of crosstalk and increases the data rate.	600	LANs

UTP connector types: LAN cable connector



Coaxial cable

- Another common transmission medium is the **coaxial cable**
- It has better shielding and greater bandwidth than unshielded twisted pairs, so it can span longer distances at higher speeds.
- A coaxial cable consists of a stiff copper wire as the core, surrounded by an insulating material.
- The insulator is encased by a cylindrical conductor, often as a closely woven braided mesh.
- The outer conductor is covered in a protective plastic sheath.



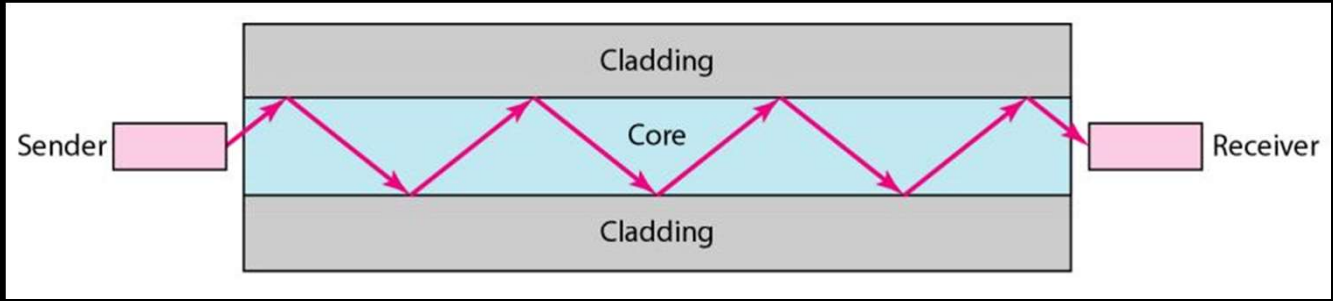
Coaxial cable types

- Two kinds of coaxial cable are widely used.
- One kind, 50-ohm cable, is commonly used when it is intended for digital transmission from the start.
- The other kind, 75-ohm cable, is commonly used for analog transmission and cable television.

Category	*Impedance*	*Use*
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet

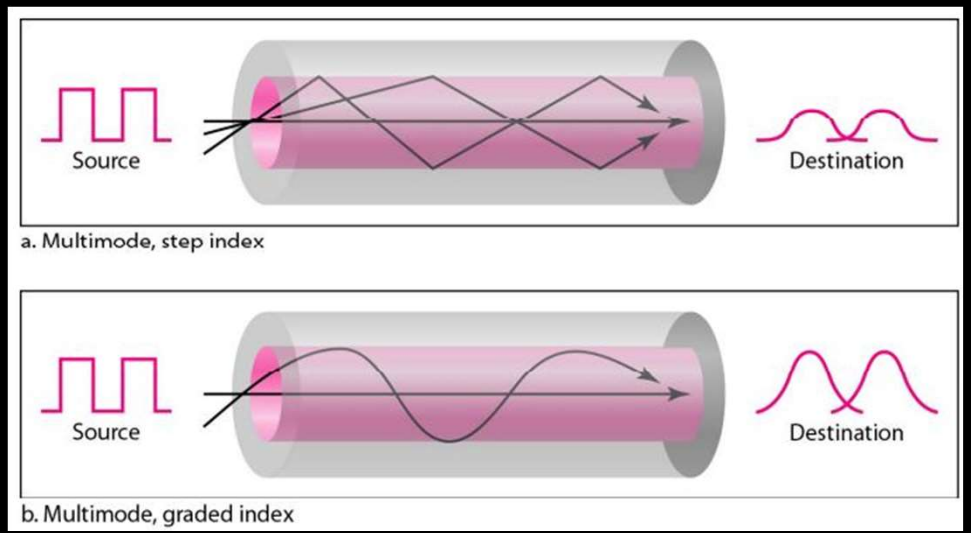
Optical fiber

- In the ongoing race between computing and communication, communication may yet win because of fiber optic networks.
- The implication of this would be essentially infinite bandwidth and a new conventional wisdom that computers are hopelessly slow so that networks should try to avoid computation at all costs, no matter how much bandwidth that wastes.



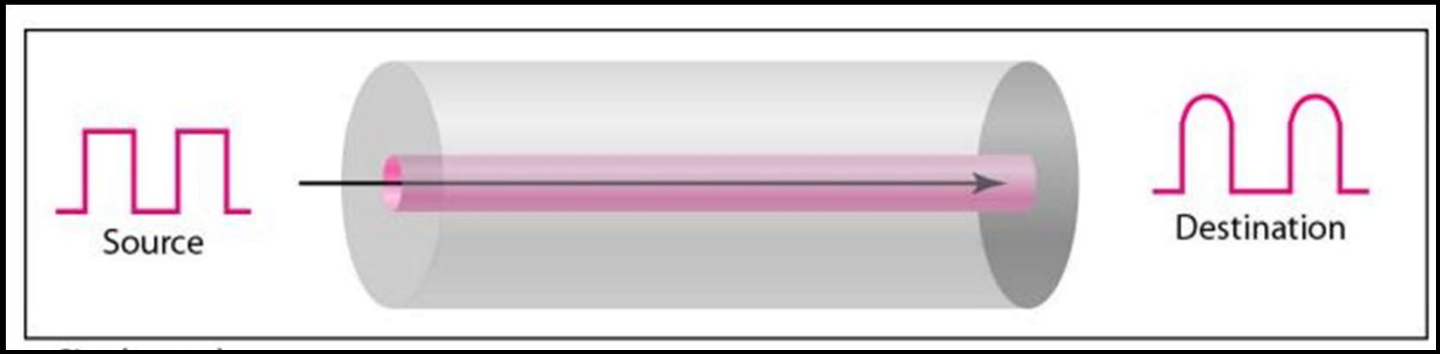
Optical fiber types.

- Multi-mode fiber:
  - Because a single light ray incident on the boundary above the critical angle will be reflected internally, many different rays will be bouncing around at different angles.
  - Each ray is said to have a different mode, so a fiber having this property is called a multimode fiber.
  - In case of **step-index fiber** the refractive index changes significantly.
  - In case of **graded-index**



Optical fiber types.

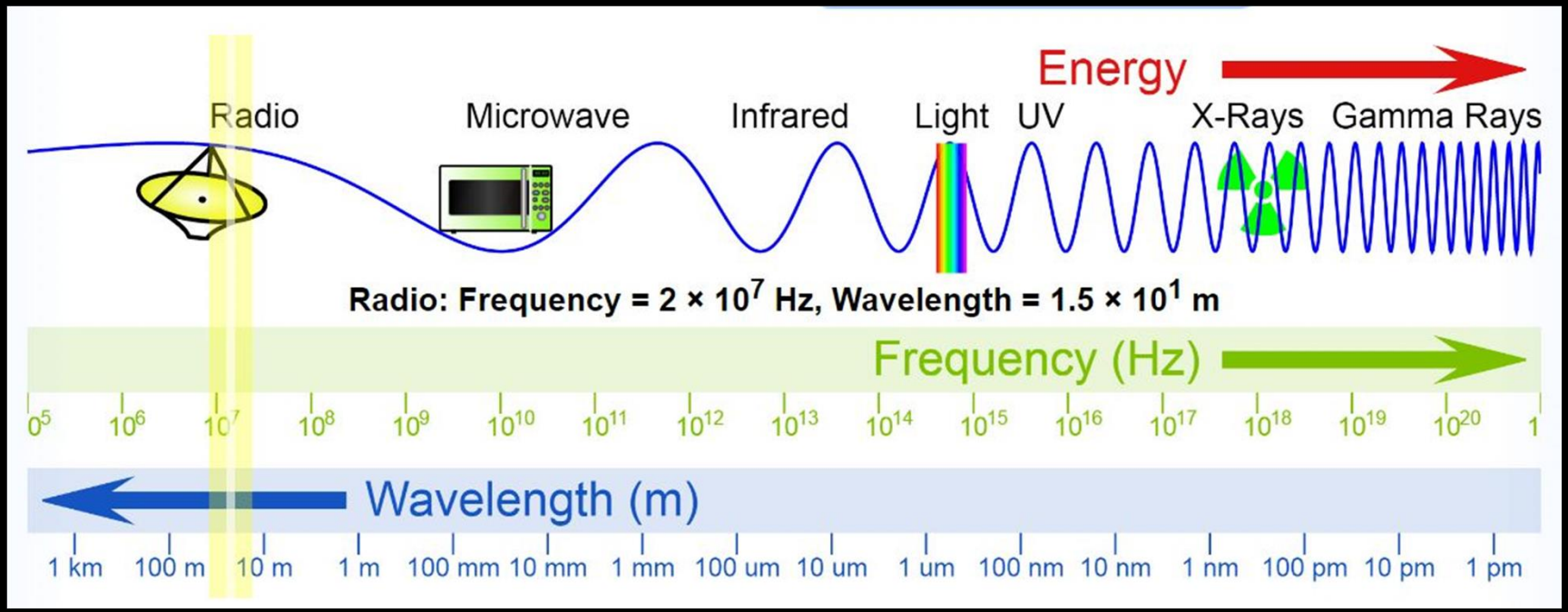
- Single-mode fiber:
  - If the fiber's diameter is reduced to a few wavelengths of light the fiber acts like a wave guide.
  - The light can propagate only in a straight line, without bouncing, yielding a single-mode fiber.



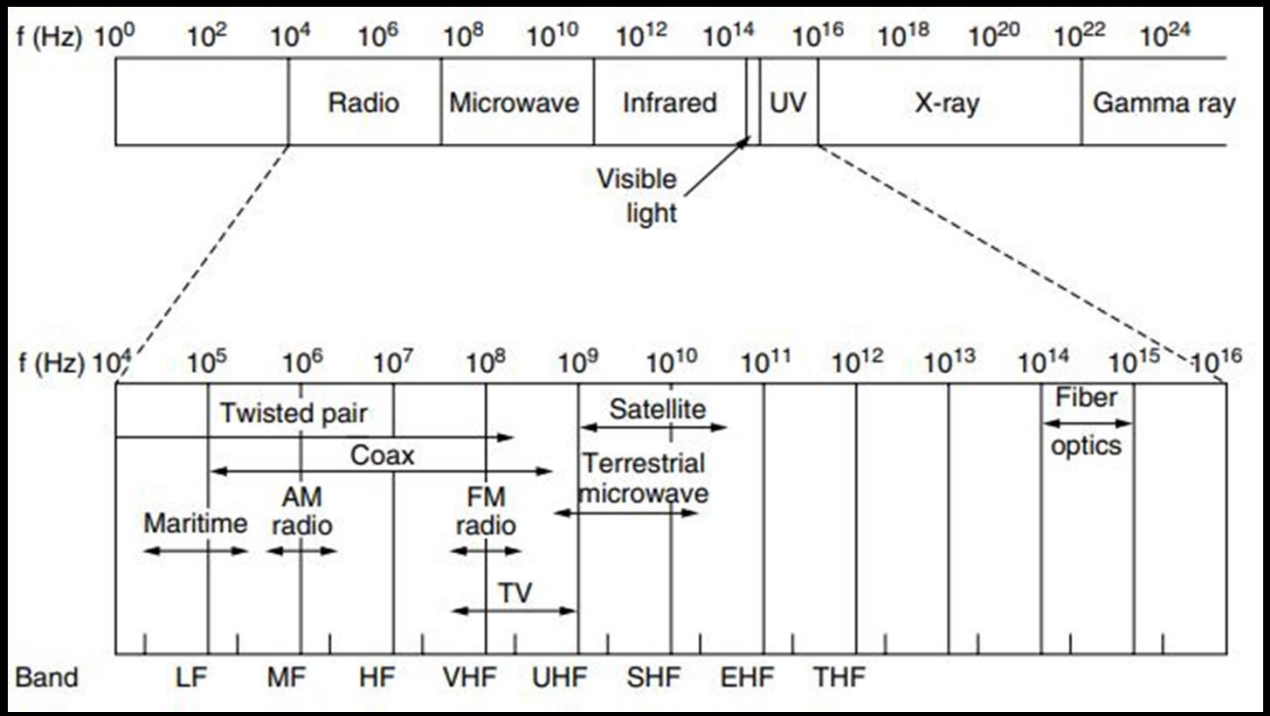
Unguided Media: Wireless

- Unguided media transport electromagnetic electro-magnetic waves without using a physical conductor.
- This type of communication is often referred to as wireless communication.

The Electromagnetic Spectrum



The Electromagnetic Spectrum



The Electromagnetic Spectrum

- The radio, microwave, infrared, and visible light portions of the spectrum can all be used for transmitting information.
- It is done by modulating the amplitude, frequency, or phase of the waves.
- Most transmissions use a relatively narrow frequency band to use the spectrum efficiently and obtain reasonable data rates by transmitting with enough power.
- However, in some cases, a wider band is used, with three variations.
  - Frequency hopping spread spectrum (FHSS)
  - Direct sequence spread spectrum (DSSS)
  - UWB (Ultra Wide Band) communication

Diff. between FHSS, DSSS & UWB

Note: FHSS, DSSS & UWB are signal spreading techniques

Standard	Bluetooth	UWB	Zigbee	Wi-Fi
IEEE spec..	802.15.1	802.15.3a	802.15.4	802.11a/b/g
Frequency band	2.4GHz	3.1-10.6 GHz	868/915 MHz; 2.4 GHz	2.4 GHz; 5 GHz
Max signal rate	1 Mb/s	110Mb/s	250kb/s	54Mb/s
Nominal range	10 m	10 m	10-100 m	100 m
Nominal TX power	0 - 10 dBm	-41.3 dBm/MHz	(-25) - 0 dBm	15 - 20 dBm
Number of RF channels	79	(1-15)	1/10;16	14(2.4GHz)
Channel bandwidth	1MHZ	500MHz-7.5GHz	0.3/0.6 MHz; 2 MHz	22MHz
Modulation type	GFSK	BPSK, QPSK	BPSK (+ ASK), O-QPSK	BPSK, QPSK COFDM, CCK, M-QAM
Spreading	FHSS	DS-UWB, MB-OFDM	DSSS	DSSS, CCK, OFDM

Radio Transmission

- Radio frequency (RF) waves are easy to generate, can travel long distances, and can penetrate buildings easily, so they are widely used for communication, both indoors and outdoors.
- Radio waves also are Omni-directional, meaning that they travel in all directions from the source, so the transmitter and receiver do not have to be carefully aligned physically.
- Radio waves follow the ground, can be detected for perhaps 1000 km at the lower frequencies.
- The main problem with using these bands for data communication is their low bandwidth

Diff. between Radio & Microwaves

- Microwaves are electromagnetic waves with frequencies between 300MHz (0.3GHz) and 300GHz in the electromagnetic spectrum.
- Radio waves are electromagnetic waves within the frequencies 30KHz - 300GHz, and include microwaves.
- Microwaves are at the higher frequency end of the radio wave band and low frequency radio waves are at the lower frequency end

Microwave Transmission

- Microwaves travel in a straight line, so if the towers are too far apart, the earth will get in the way.
- Thus, repeaters are needed periodically.
- Unlike radio waves at lower frequencies, microwaves do not pass through buildings well.
- The refracted waves may arrive with a delay, out of phase with the direct wave and thus cancel the signal.
- This effect is called multipath fading and is often a serious problem.

Infrared Transmission

- Unguided infrared waves are widely used for short-range communication.
- The remote controls used for televisions, VCRs, and stereos all use infrared communication.
- Major drawback: they do not pass through solid objects.
- The fact that infrared waves do not pass through solid walls well is also a plus.
- It means that an infrared system in one room of a building will not interfere with a similar system in adjacent rooms or buildings.
- No government license is needed to operate an infrared system, in contrast to radio systems