Sun 11 Jan

Chapter 02

Physical Layer

- Data Communications and Networking, With TCP/IP protocol suite Sixth Edition
- Behrouz A. Forouzan

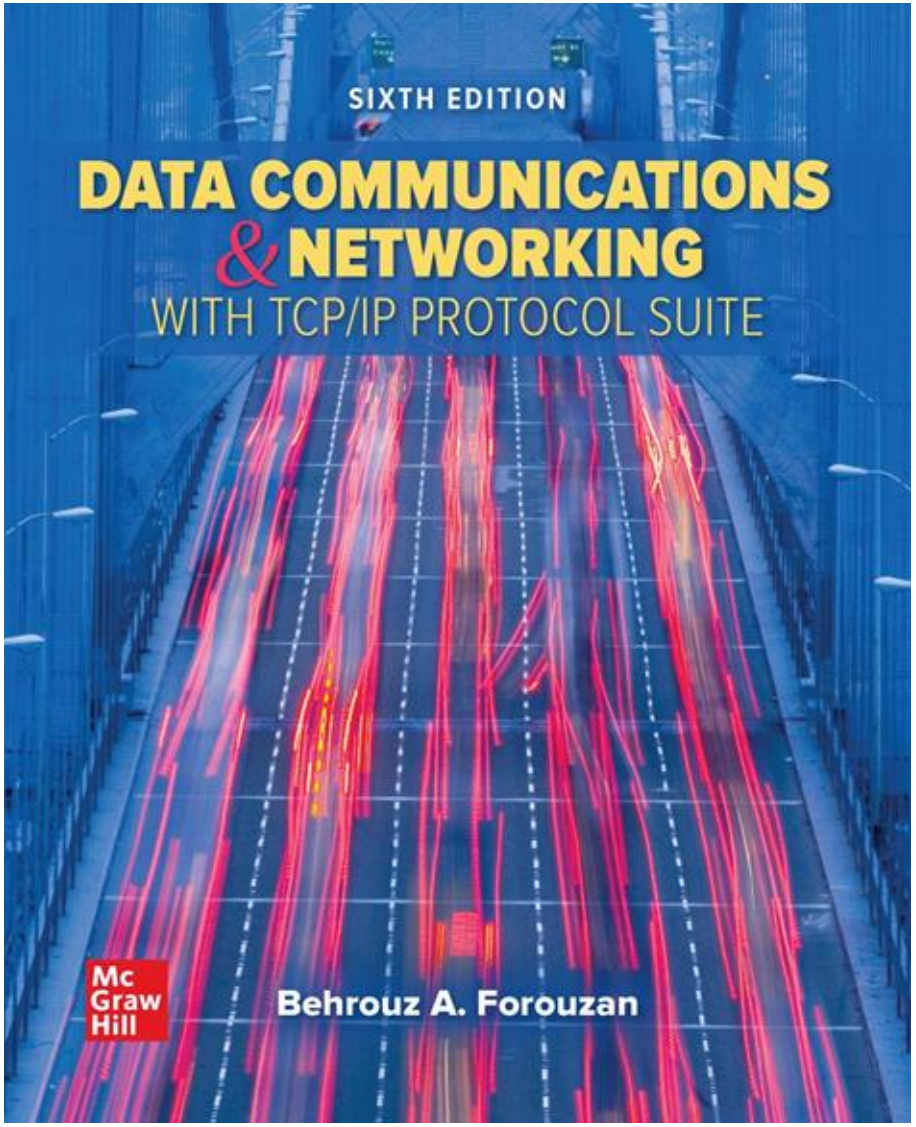


Figure 7.1 *Transmission medium and physical layer*

- Transmission medium(channel): the physical path between the transmitter and the receiver.
- Located below the physical layer
- Controlled by the physical layer

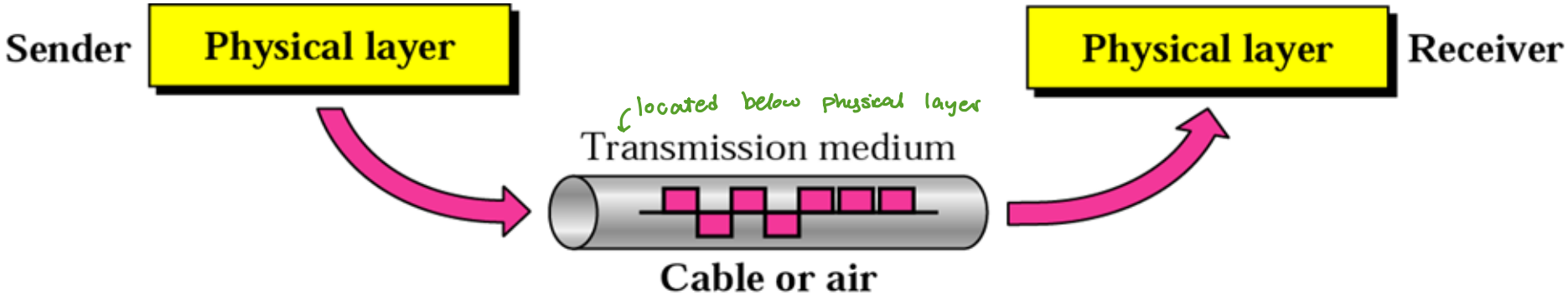
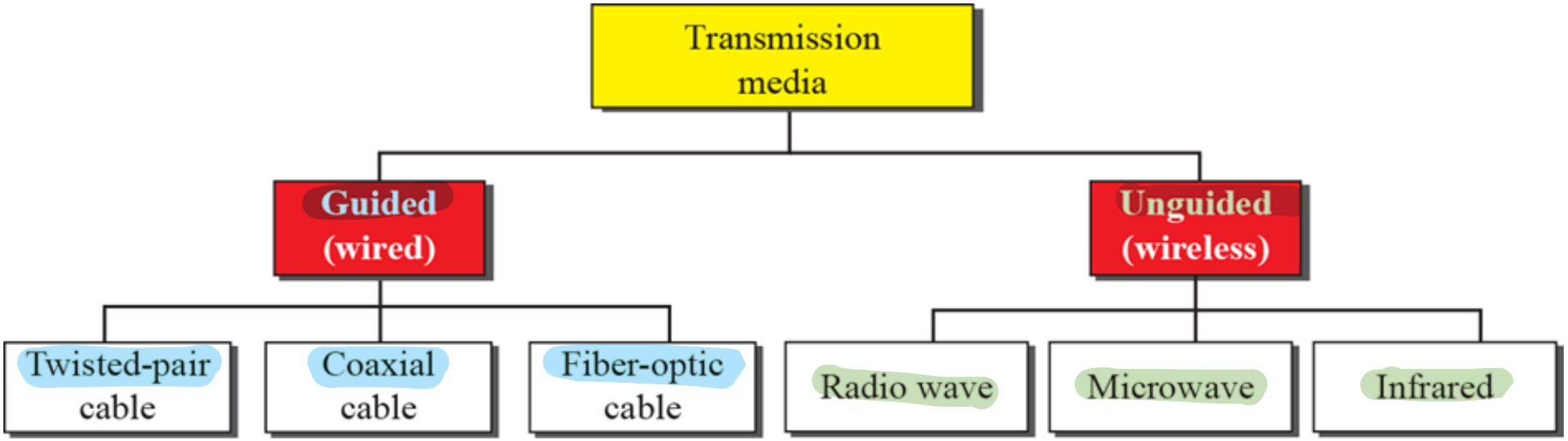


Figure 7.2: Classes of transmission media



7.1 Guided Media

Twisted-Pair Cable

Coaxial Cable

Fiber-Optic Cable

Twisted pairs

8 wires
4 pairs

- pure color
- white mixed w/ color

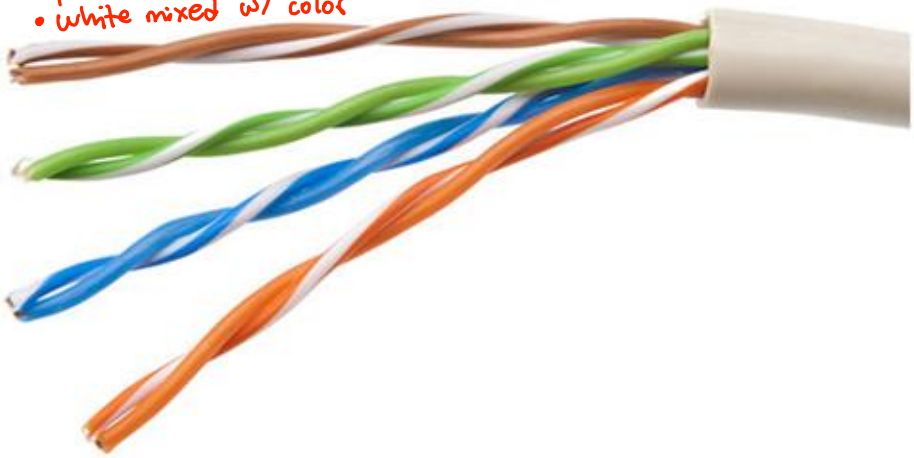


Figure 7.3 *Twisted-pair cable*

copper wire: conductor
insulator: plastic

- **A twisted pair consists of**: two insulated **copper wires** in a regular **spiral pattern**
- A **wire pair** acts as a **single communication link**
- Twisted to **reduce electrical interference** from similar pairs **close by** (more twists means better quality)
  creating field around it
- Used in:
  - Telephone network Between house and local exchange (subscriber loop)
  - LAN

# of twist makes difference

Twisted Pair

Twist length of 7.5 cm to 10 cm

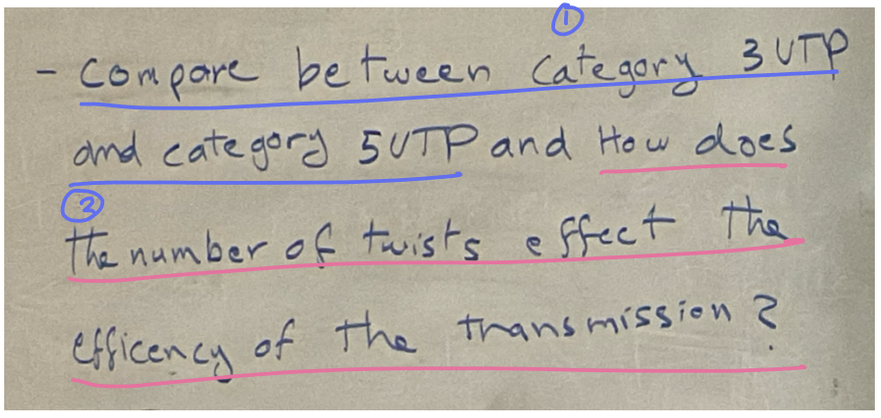
(a)

Twist length 0.6 cm to 0.85 cm

(b)

(a) Category 3 UTP. (b) Category 5 UTP.

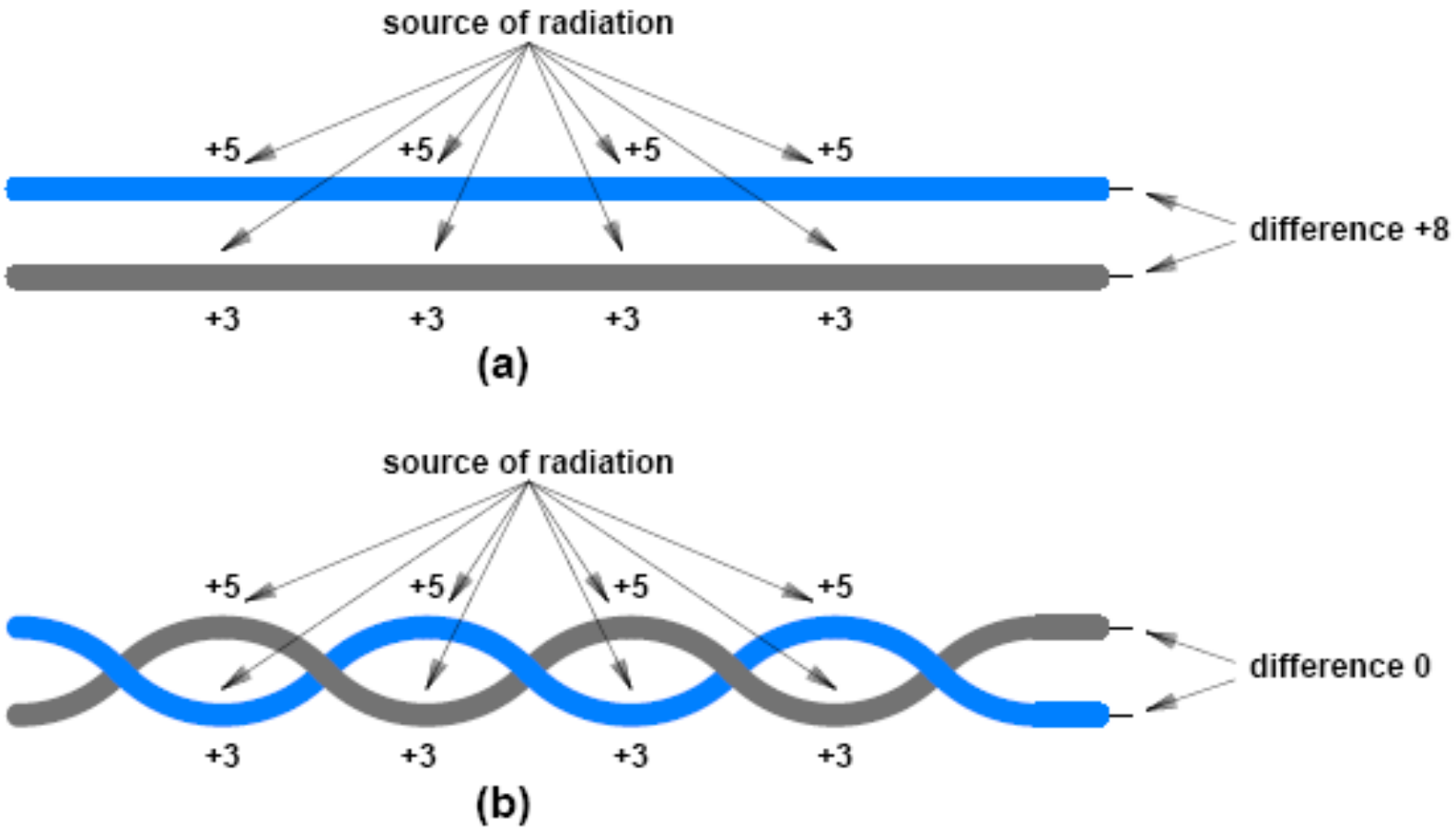
more twists, bigger num



(1)

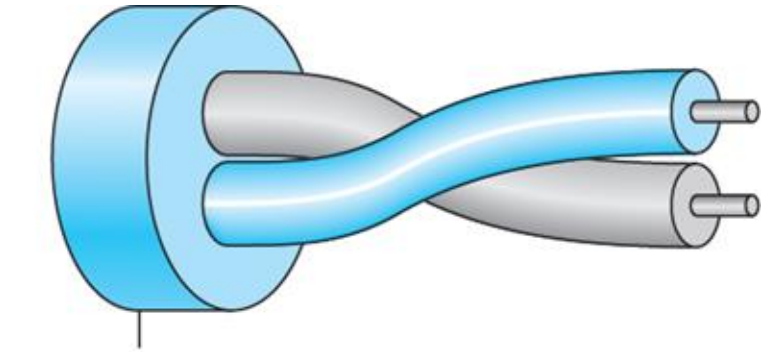
	Speed	Frequency	used ?
cat 3	10Mbps	16MHz	token rink & 10BASE-T Ethernet
cat 5	100 Mbps	100 MHz	Ethernet, Token Rink

(2) increase by enhancing cable ability to minimize internal crosstalk & reject EMI

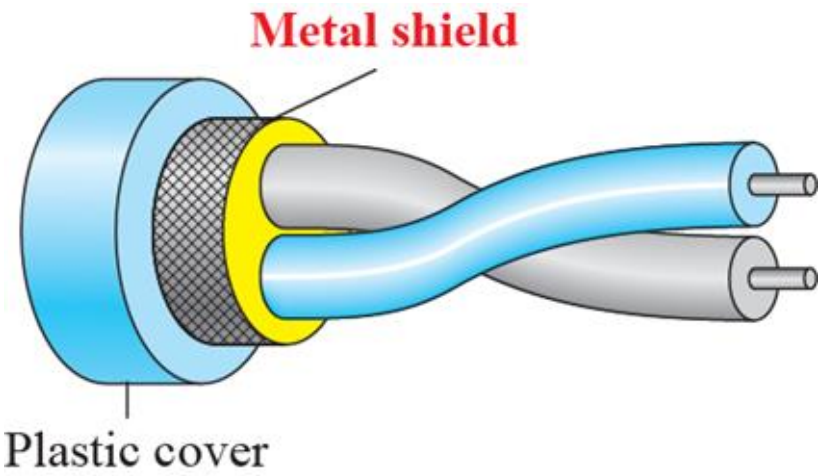


Unwanted electromagnetic radiation affecting (a) two parallel wires, and (b) twisted pair wiring.

Figure 7.4: UTP and STP cables



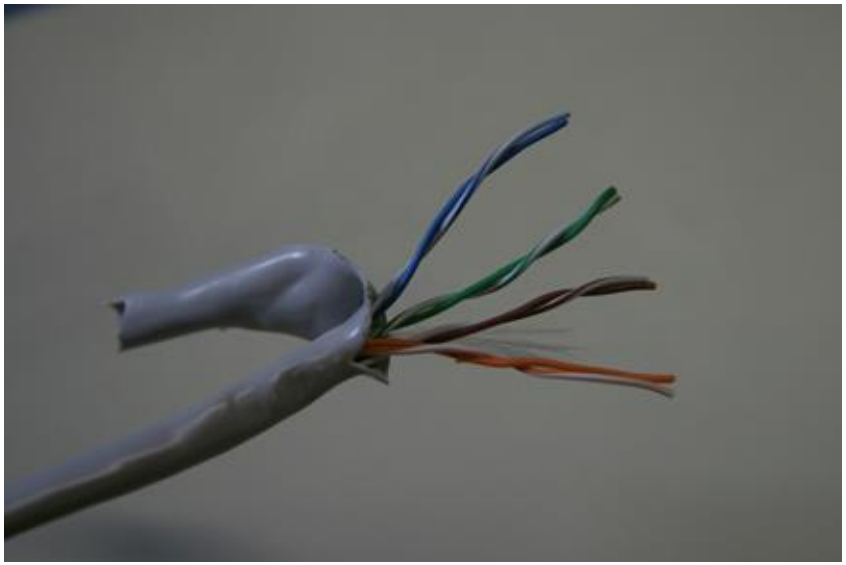
a. UTP

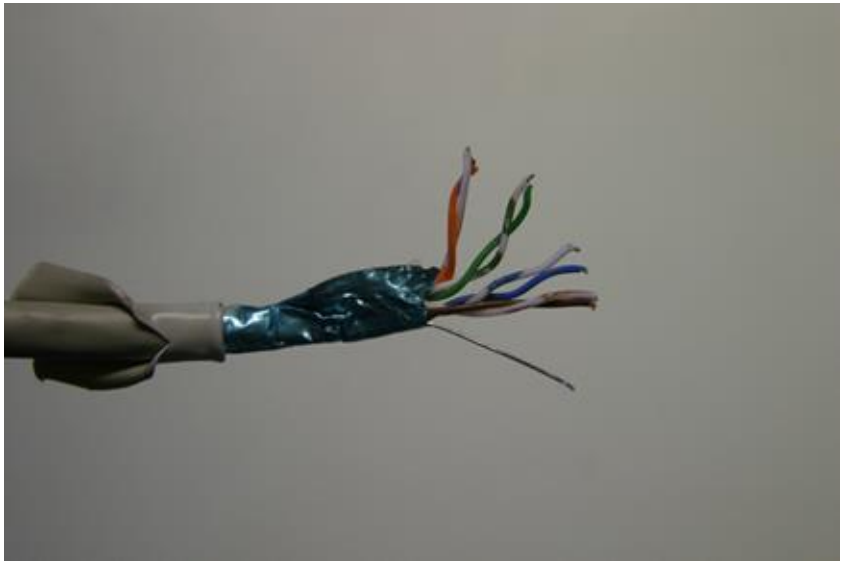


b. STP

UTP: Unshielded Twisted Pair

STP: Shielded Twisted Pair





Unshielded Twisted Pair (UTP)

- Cheapest type of cable
- Easiest type to be installed
- Suffers from external Electromagnetic (EMI) interference

Shielded Twisted Pair (STP)

- Metal braid or covering that reduces interference
- More expensive $$
- Harder to handle (thick, heavy)

Can search on my own !!

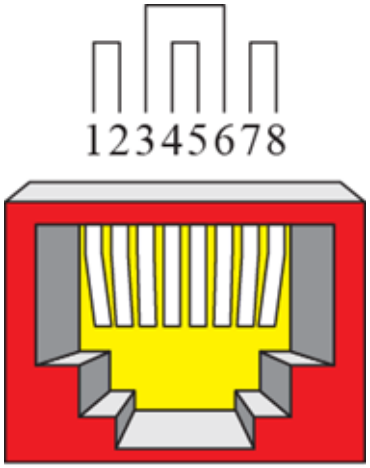
Table 7.1 Categories of unshielded twisted-pair cables

Category	Bandwidth	Max Data Rate	Shielding
CAT5e	100 MHz	1000 Mbps	UTP or STP
CAT6	250 MHz	1000 Mbps	UTP or STP
CAT6a	500 MHz	10 Gbps	UTP or STP
CAT7	600 MHz	10 Gbps	Shielded only
CAT8	2000MHz	25 Gbps or 40 Gbps	Shielded only

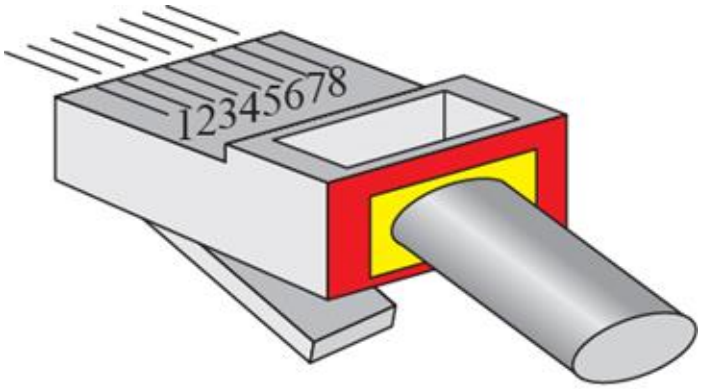
not for quiz but maybe major

Shielded CAT8 up to 40Gbps – 24 m

Figure 7.5: UTP Connectors

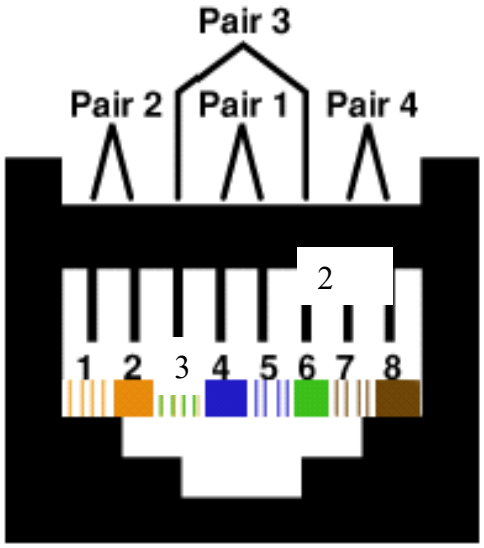


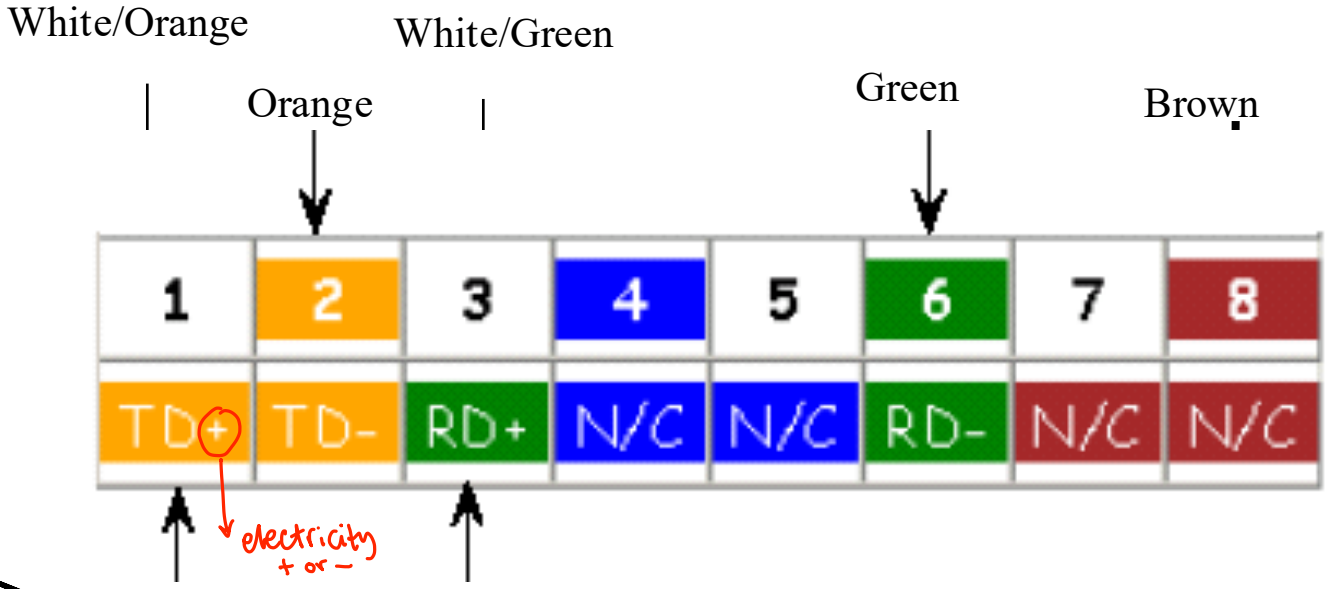
RJ-45 Female

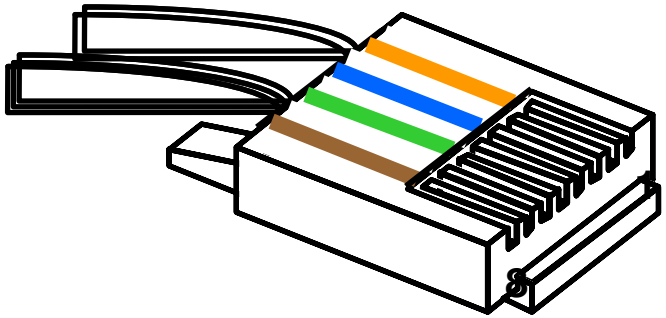


RJ-45 Male

RJ=Registered Jack



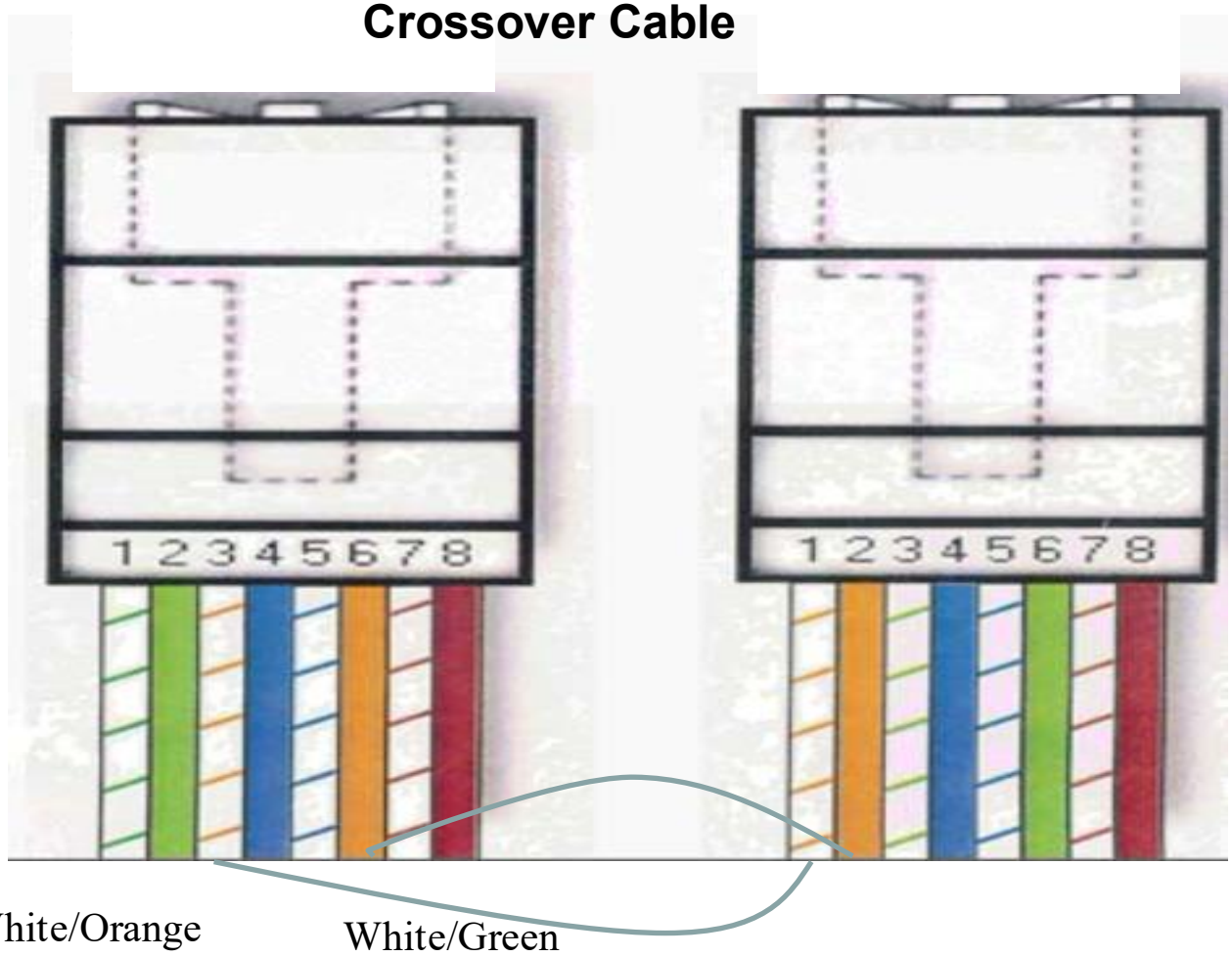


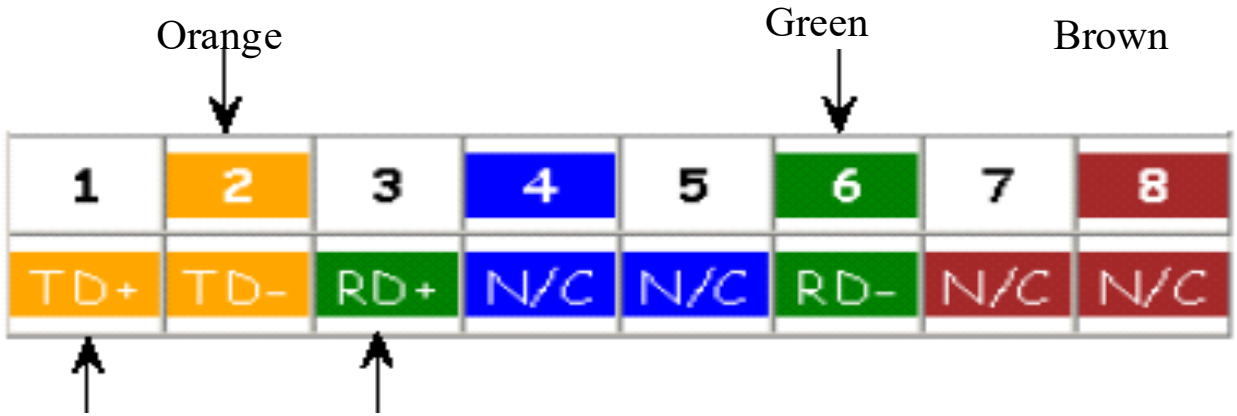


The RJ-45 Connector

TD+ : Transmit Data Positive value
TD- : Transmit Data Negative value
RD+ : Receive Data Positive value
RD- : Receive Data Negative value

Crossover Cable



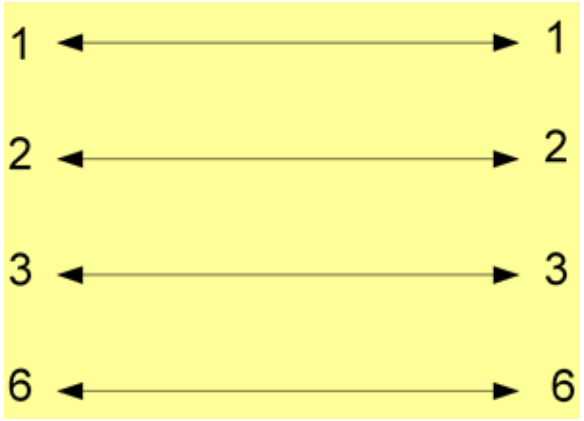


TD+ : Transmit Data Positive value
TD- : Transmit Data Negative value
RD+ : Receive Data Positive value
RD- : Receive Data Negative value

Mon 12 Jan

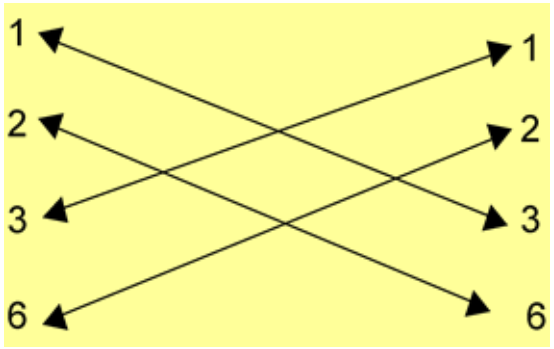
Ethernet Cabling

- Straight-Through Cabling



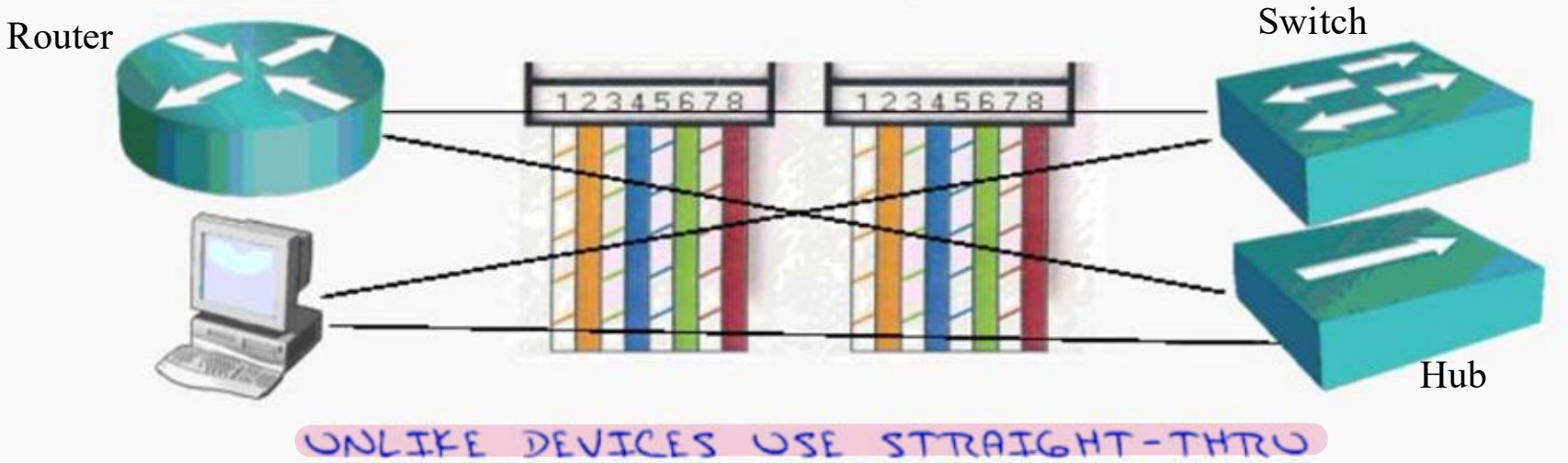
- **PC to Switch/Hub**
- **Router to Switch/Hub**

- Crossover Cabling

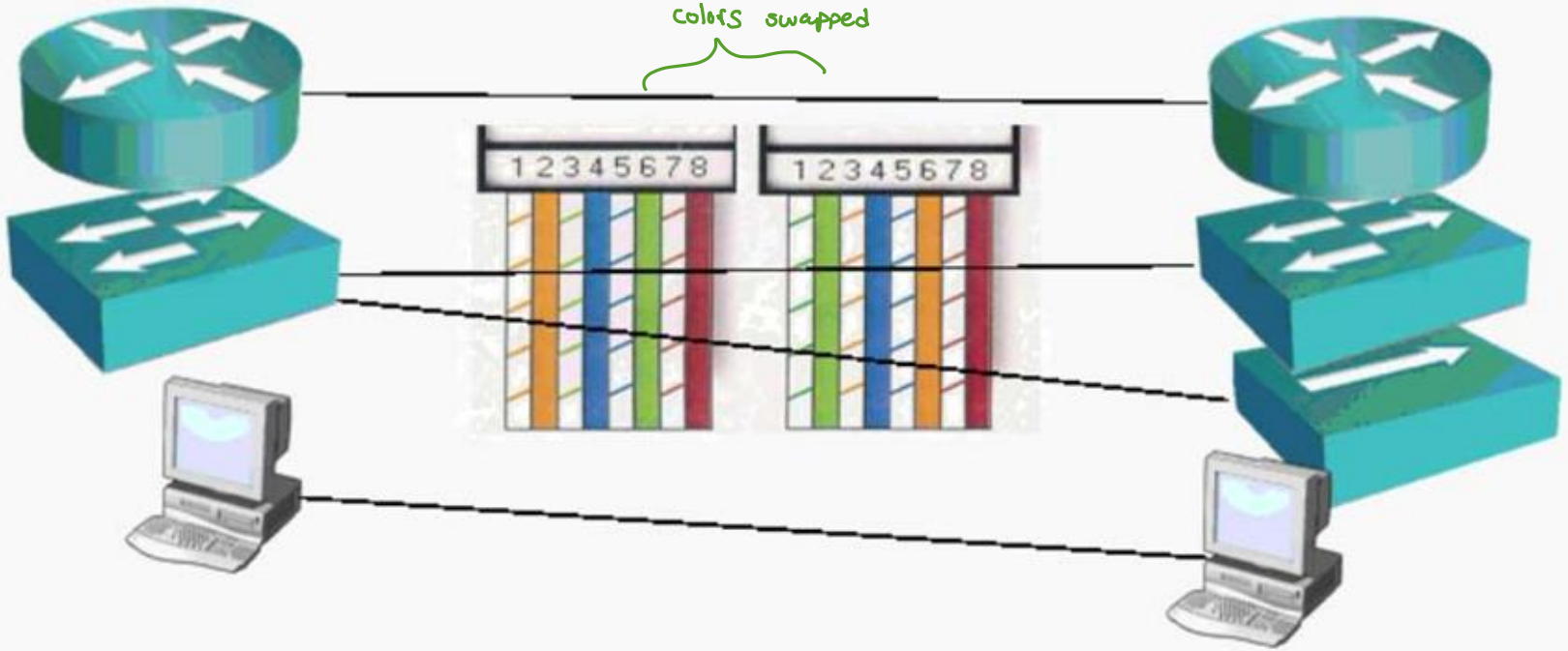


- **PC to PC**
- **Hub to Hub**
- **Switch to Switch**
- **Hub to Switch**
- **Router to PC**

Ethernet Connection Rules



UNLIKE DEVICES USE STRAIGHT-THRU



LIKE DEVICES USE CROSSOVER

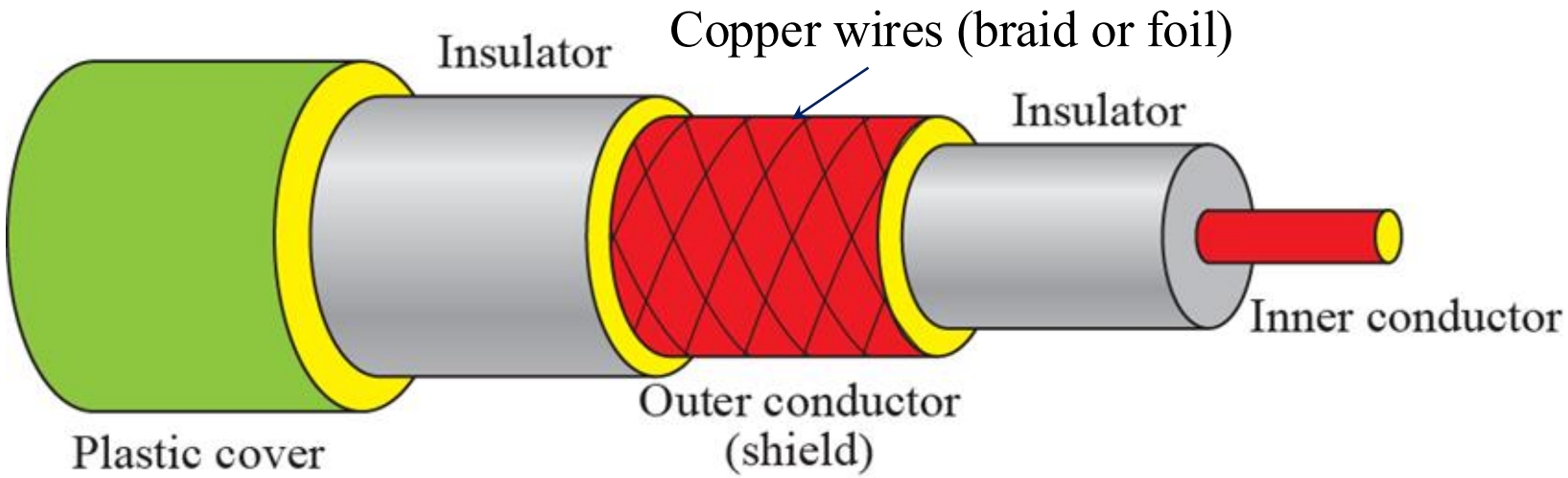
Figure 7.7: Coaxial cable

2 different layers

more $$

more effesient in stopping interference

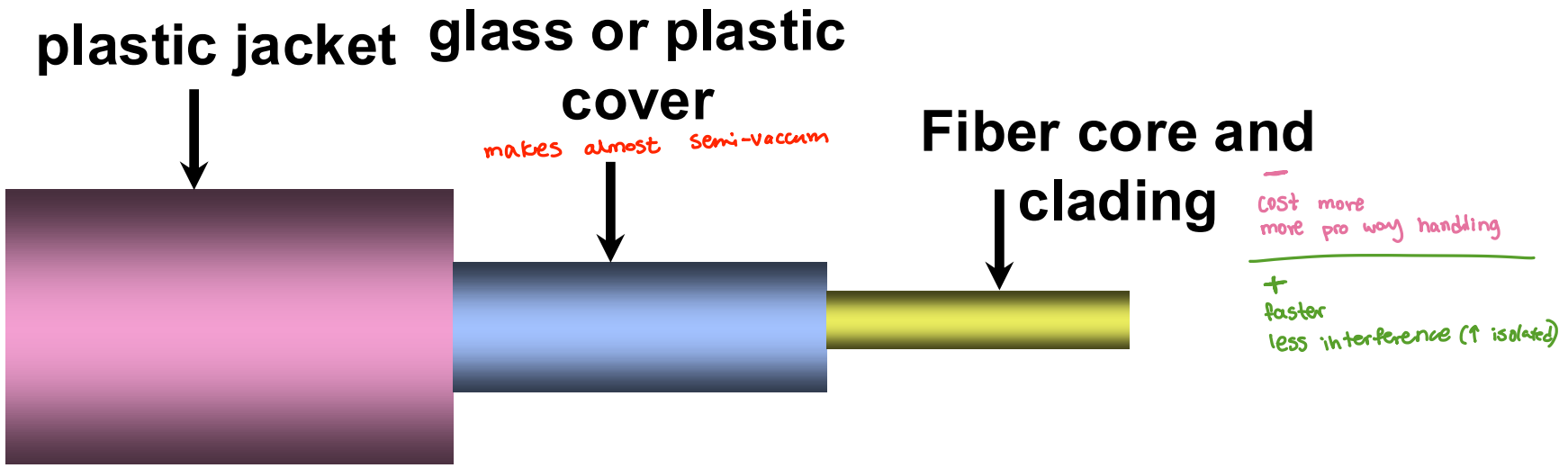
Coaxial Cable



Optical Fiber

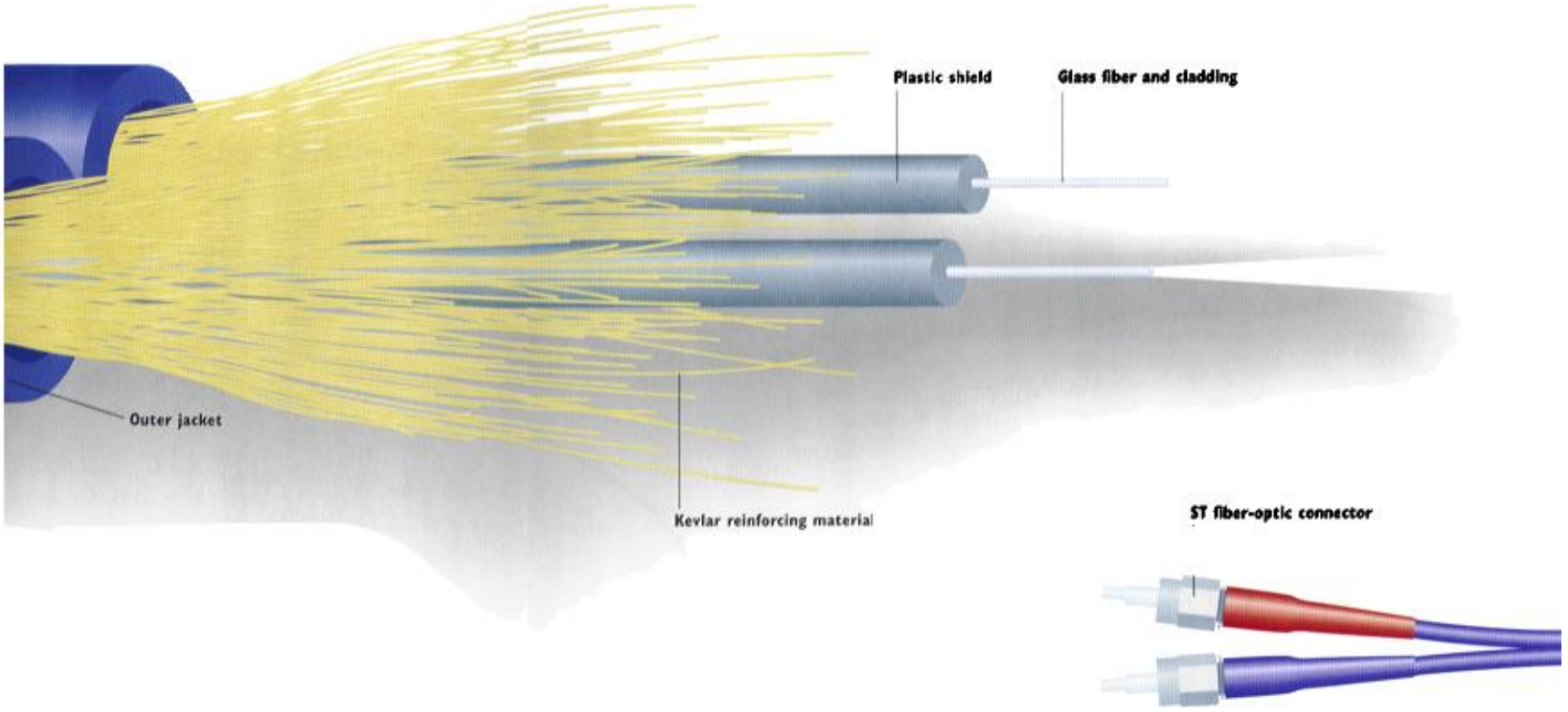
light pulses (speed of light)

- consists of **three concentric sections**



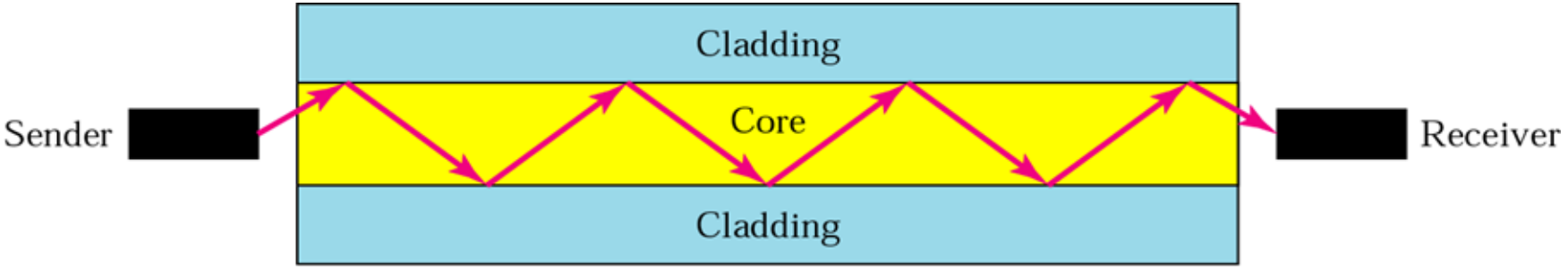
- **Core**: consists of one or more very thin s**trands** or fibers made of **glass** or **plastic**
- Each fiber is surrounded by its own **cladding**, a **glass or plastic coating that has optical properties different from the core**
- **Jacket**: a plastic or other material acts as a layer to protect against moisture, crushing, and other environmental dangers.

Fiber Optic Cable



Optical Fiber

Bounce over walls, until reciever
* animation will be provided *



Fiber Optics Properties

Advantages

- **Higher Bandwidth**
  - Data rates of hundreds of Gbps
- Smaller **size & weight**
- **Lower attenuation** (signal loss)
  - **Greater repeater spacing**
  - Can run 50Km at least without repreaters
- **No crosstalk** (no light leaking)
- Not affected by noise
- **highly secure** (no light leaking)

Disadvantages

- Needs special skills to install
- Cost: **more expensive** interfaces than electrical interfaces used with other types (twisted)

Implementation Issues	**UTP Cabling**	**Fiber-Optic Cabling**
Bandwidth supported	10 Mb/s - 10 Gb/s	10 Mb/s - 100 Gb/s
Distance	Relatively short (1 - 100 meters)	Relatively long (1 - 100,000 meters)
Immunity to EMI and Radio Frequency Interference	Low	High (Completely immune)
Immunity to electrical hazards	Low	High (Completely immune)
Media and connector costs	Lowest 	Highest 
Installation skills required	Lowest	Highest

7.2 Unguided Media: Wireless

Radio Waves

Microwaves

Infrared

Figure 7.19 *Wireless transmission waves*

Unguided media: signals are transmitted through air and are available to everyone who has a device that can receive them

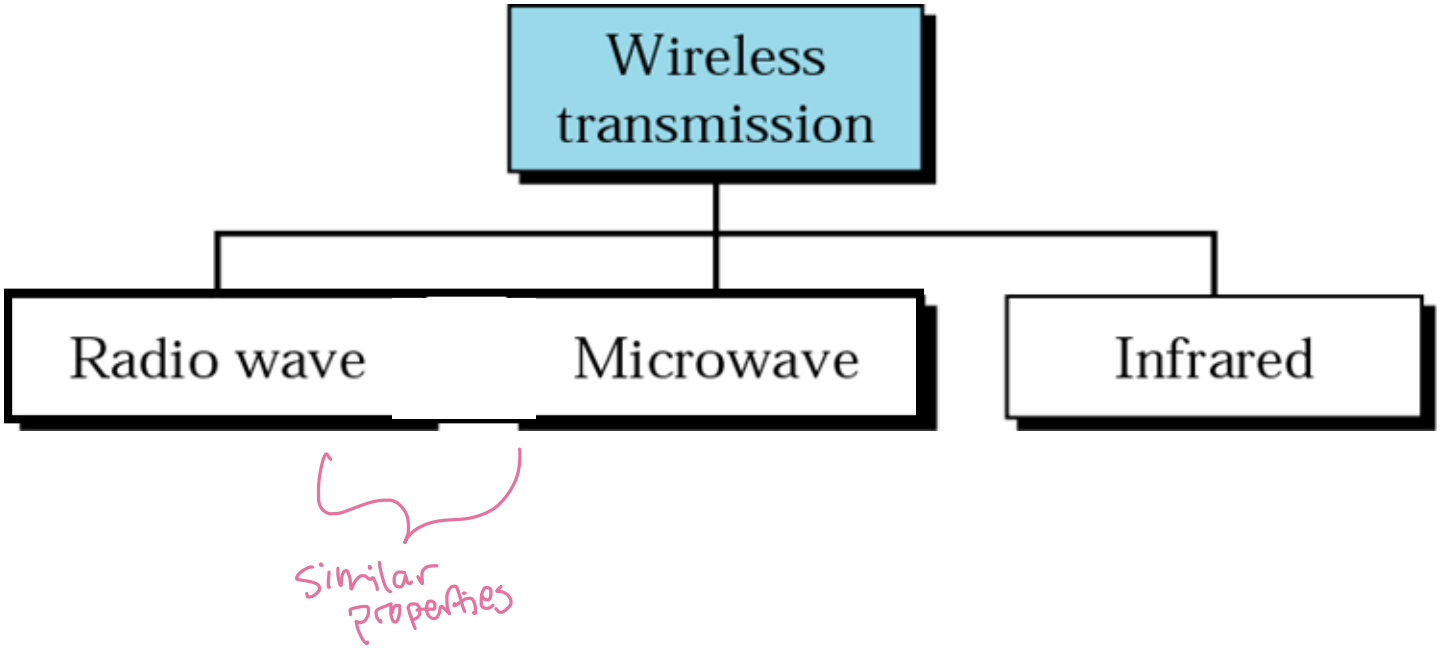
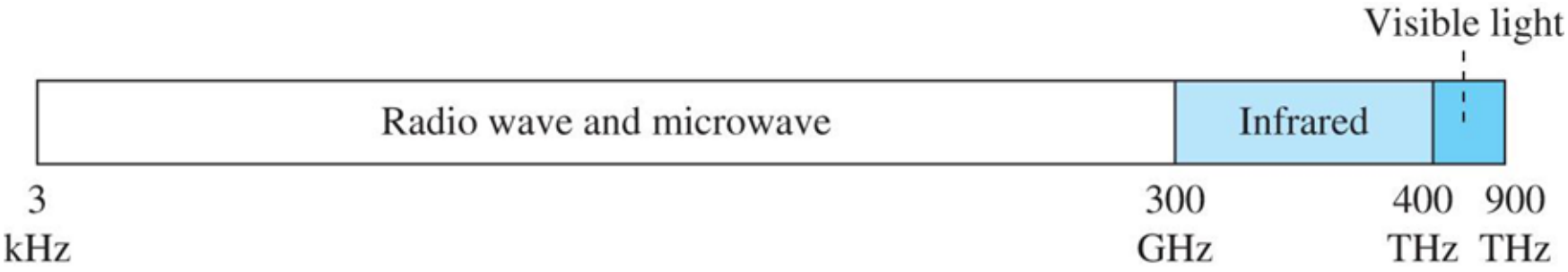
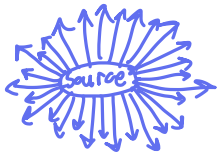


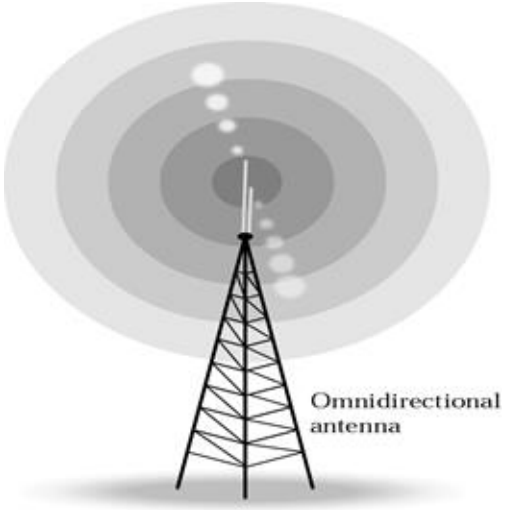
Figure 2.25 Electromagnetic spectrum for wireless communication



Radio waves



- Less than 300 MHz
  - **Omnidirectional** (signal propagates in all directions)
  - Can Travel long distances
  - Broadcast radio (AM,FM) ,TV



put in mind

Note

Radio waves are used for multicast communications, such as radio and television

!!

!!

link to what before?

Microwaves

- **300MHz to 300GHz (sub range from the Radio waves)**
  - Travel in one direction (Unidirectional = line-of-sight propagation = straight lines)
  - Can be used for point to point for example between buildings to connect their LANs
  - Very high frequency microwaves, **cannot penetrate walls (disadv. if receivers are inside buildings**)
  - Used in Wireless networks, satellite communication, cellular phones

Note

Microwaves are used for unicast communication such as cellular telephones, satellite networks, and wireless LANs.

3

Infrared

mixed with sunlight, won't work well

- 300GHz to 400THz
  - Have a very large bandwidth that is not yet completely utilized
  - Local- short distance communication because they cannot penetrate walls
  - Line-of-sight propagation (directional)
  - Used in local point-to-point Transmission
  - Applications: Wireless keyboard, mouse, remote control using **Infrared Data Association (IrDA) protocol**
  - **Cannot be used under the sun because** of the interference with the sun infrared rays
  - IrDA operates at 75kbps up to **8 meters**, and 1.15Mbps – 4Mbps over a distance of **1 meter**

Note

Infrared signals can be used for short-range communication in a closed area using line-of-sight propagation.

affected by sun

Quiz:

① MCQ
- Solving → (pen, pencil, calculator)
- theory

② T/F

Essay-based → Major