

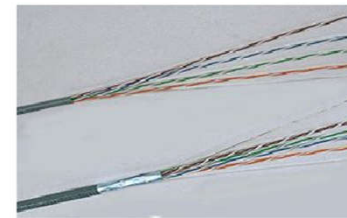
# CHAPTER-2

## NETWORK CABLES AND CONNECTIVITY DEVICES

### Network Media



Copper



Fiber Optics



Wireless



# Connectivity Devices

# Major Networking Devices

**Hub**



**Gateway**



**Router**



**Repeater**



**Bridge**



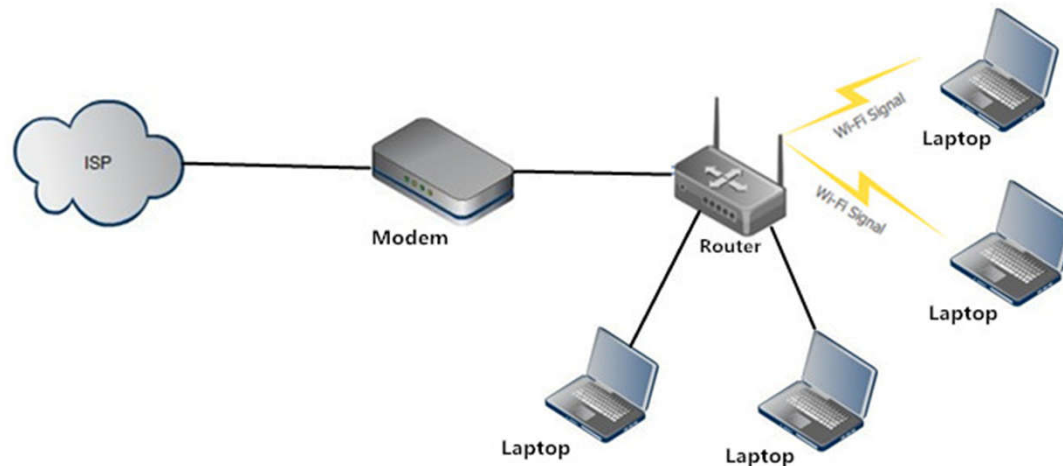
**Switch**



# Networking Devices

## Modem

- Modem converts digital signals of computers into analog signals that are transmitted through analog telephone lines and vice versa at the receiving end.
  - Binary data (0s and 1s) is generated by computers and analog signal is carried by a wire
- Modem works as **Modulator – Demodulator**.
  - A **modulator** when it converts digital data into analog signal
  - A **demodulator** when it converts analog signal to digital data



# Networking Devices

## Repeater

- A repeater is an electronic device that receives a weak or low-level signal and retransmits it at a higher level, so that the signal can cover longer distances without degradation.
  - Length of the cable affects the quality of communication
- Repeater repeats the signal—clean and boost the signal
  - When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength.



# Networking Devices

## Hub

- Hubs are commonly used to connect segments (devices) of a LAN.
- Hubs don't filter information, instead broadcast incoming packets to all computers connected to it.
- A hub contains multiple ports,
  - Support 8, 12 or 24 RJ-45 ports
- Two types
  - *Passive hub*
  - *Active hub*
- Used in star or ring topology.

# Networking Devices

## Switch

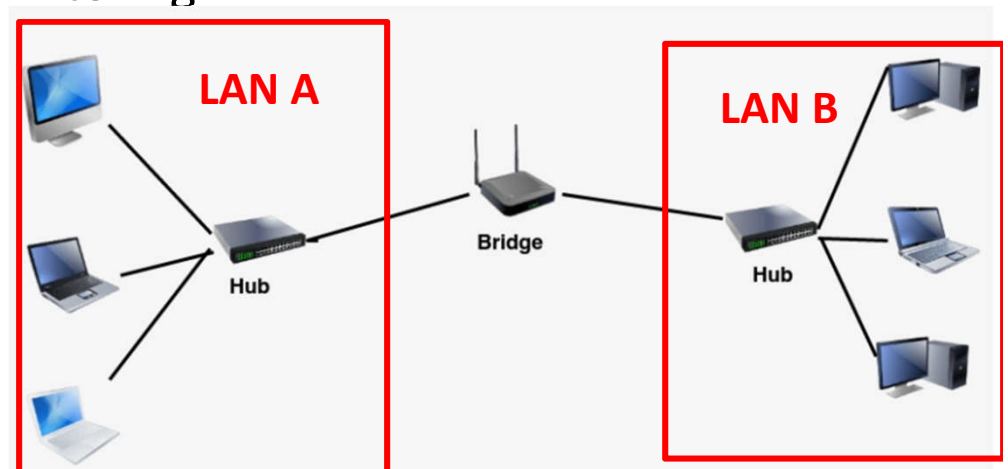
- A switch filters and forwards data packets across a network
- Unlike a hub which simply replicates what it receives on one port onto all the other ports, a switch keeps a record of the MAC addresses of the devices attached to it.
- When the switch receives a data packet, it forwards the packet directly to the recipient device by looking up the MAC address.
  - **Switch** is intelligent and expensive than **Hub**
  - **Switch** is a point to point communication device
  - **Hub** is a broadcasting device



# Networking Devices

## Bridge

- Connects two LANs having the same protocol – (e.g. Ethernet or Token ring)
- Filters content by reading the MAC addresses of source and destination.
  - MAC to Segment number table
  - Do not filter broadcast
  - Data not destined for other network is prevented from passing over the bridge
  - Slower than repeater due to filtering

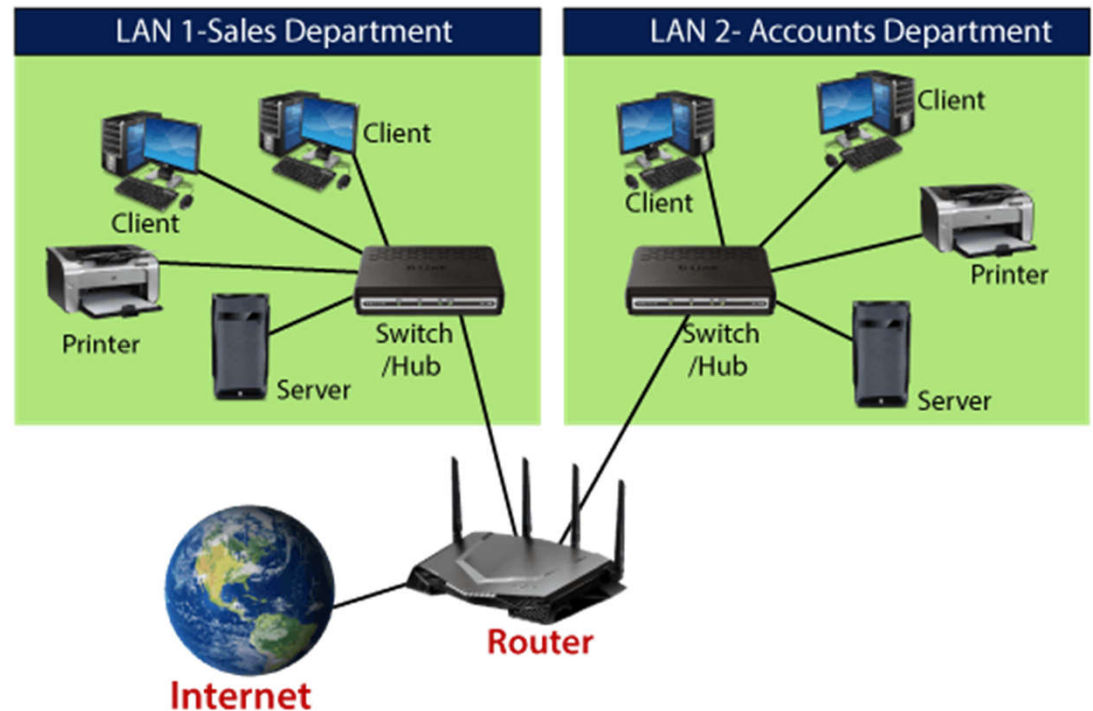




# Networking Devices

## Router

- Router is a specialized network device used to interconnect different types of network that uses different protocol
- Router allows the users to connect several LAN and WAN
  - A LAN to another LAN
  - A WAN to another WAN
  - A LAN to the Internet



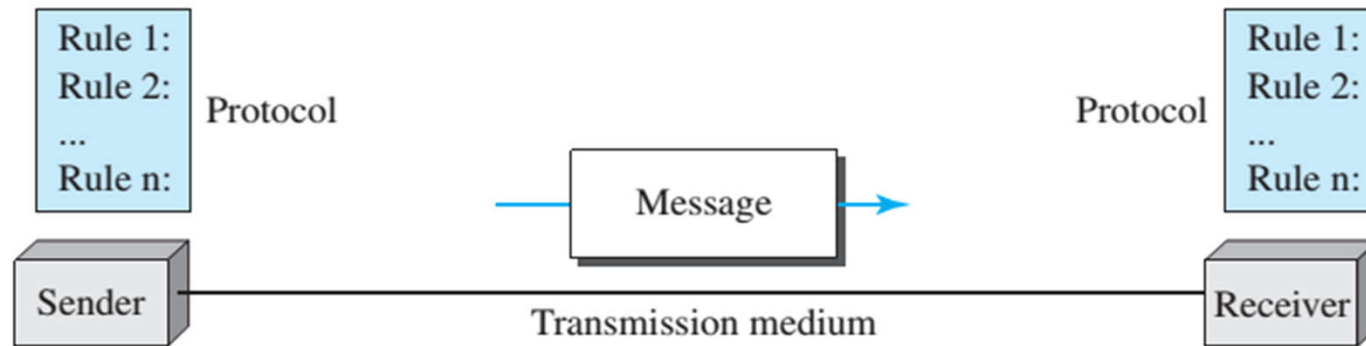
# Networking Devices

## Router

- Routers use ***the routing table*** to determine how to forward packets
  - The list of routing tables provides directions to transfer the data to a particular network destination – various paths to forward the data.
  - A router analyzes a destination IP address of a given packet and compares it with the routing table to decide the packet's next best path
- A router shares information with other routers in networking.
- ***Wireless router*** – offers Wi-Fi connectivity to laptops, smartphones, and other devices with Wi-Fi network capabilities
- **Broadband routers / Broadband modem** – provided by the internet service provider (ISP).

# Network Cables

# Network Cables - Introduction



- **Message.** The **message** is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.
- **Sender.** The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.
- **Receiver.** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.
- **Transmission medium.** The transmission medium is the physical path by which a message travels from sender to receiver. **Cable or Air**
- **Protocol.** A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices.

# Network Cables - Types

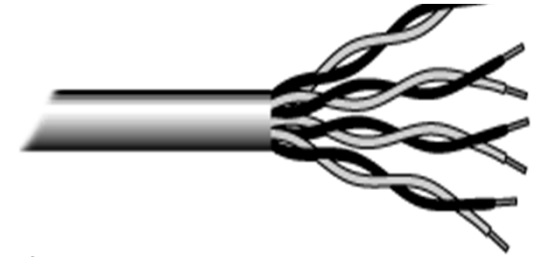
- Transmission media carry signals between computers
- Can be divided into two broad categories:

**Cable-based/Guided media**: the signal are guided along a solid medium

- **Twisted-pair cable**
  - Consists of two conductors (normally copper), each with its own plastic insulation, twisted together.
  - Two types
    - *Unshielded Twisted-Pair cable (UTP)*
    - *Shielded Twisted-Pair cable (STP)*
- **Coaxial cable**:- uses copper wire to conduct the signals electronically
- **Fiber-optic cable**:- uses glass or plastic conductor and transmits the signals as light

**Wireless/Unguided media** the signal propagates in the atmosphere and in outer space

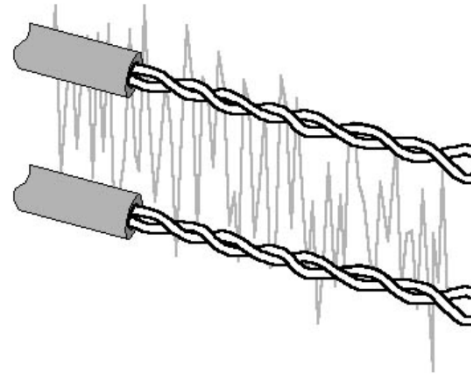
# Twisted-Pair Cable



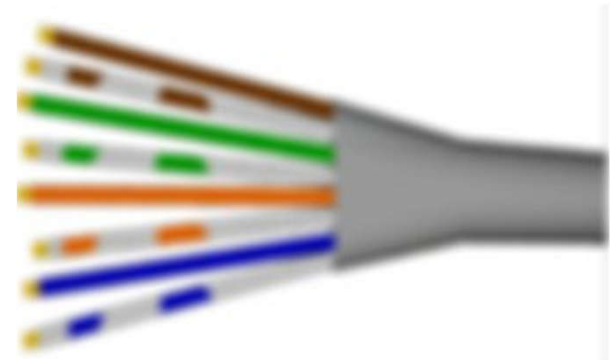
- Use metallic (copper) conductors that accept and transport signals in the form of electric current.
- Almost all modern LAN computer networks use this cable.
  - This cable is also known as **Ethernet cable**.
- Consists of color-coded pairs of insulated copper wires each about 1 mm thick
  - Every two wires are twisted around each other
  - Each pair is twisted with a different number of twists per inch to eliminate interferences which will create noise.
    - **Crosstalk** from adjacent pairs
    - **Electromagnetic** interference (EMI) from other electrical devices

# Twisted-Pair Cable (Cont'd)

- One potential problem with twisted-pair cable is **Crosstalk**
- **Crosstalk** is defined as signals from one line interfering with signals from another line.

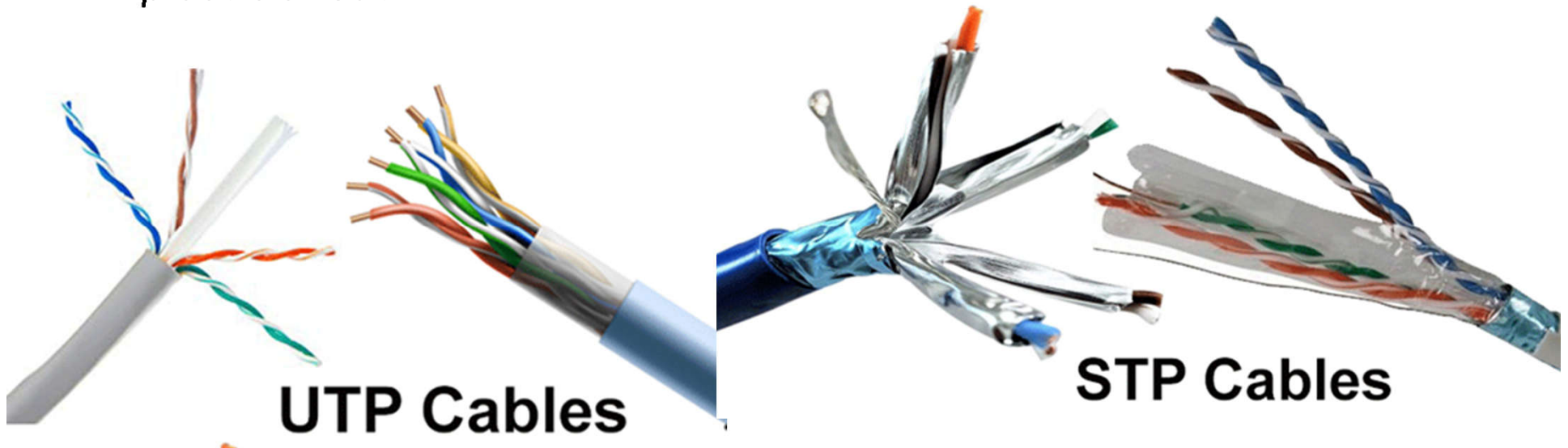


- Usually there are four pairs.
  - Each pair has one solid color and one stripped color wire.
    - Wire pair #1: **White-blue, Blue**
    - Wire pair #2: **White-orange, Orange**
    - Wire pair #3: **White-green, Green**
    - Wire pair #4: **White-brown, Brown**



# Twisted-Pair Cable (Cont'd)

- Two types of twisted-pair cable
  1. **Unshielded twisted-pair (UTP) cable**, all pairs are wrapped in a single plastic sheath.
    - The most common twisted-pair cable for LANs.
  2. **Shielded twisted-pair (STP) cable**, each pair is wrapped with an additional metal shield, then all pairs are wrapped in a single outer plastic sheath.





# Twisted-Pair Cable (Cont'd)

## STP vs. UTP cables

- Both STP and UTP can transmit data at 10Mbps, 100Mbps, 1Gbps, and 10Gbps.
- Since **STP** cable contains more materials, it is more expensive than the **UTP** cable.
  - however, the extra shielding can make the cables quite bulky.
- **UTP** is susceptible to crosstalk, radio and electrical frequency interference.
  - **STP** is more cross-talk, EMI, and attenuation resistant than the **UTP** cable.
  - **STP** is suitable for environments with electrical interference
- **STP** is often used on networks using Token Ring topology.
- Both cables use the same RJ-45 connectors.
- The maximum segment length for both cables is 100 meters

# Twisted-Pair Cable (Cont'd)

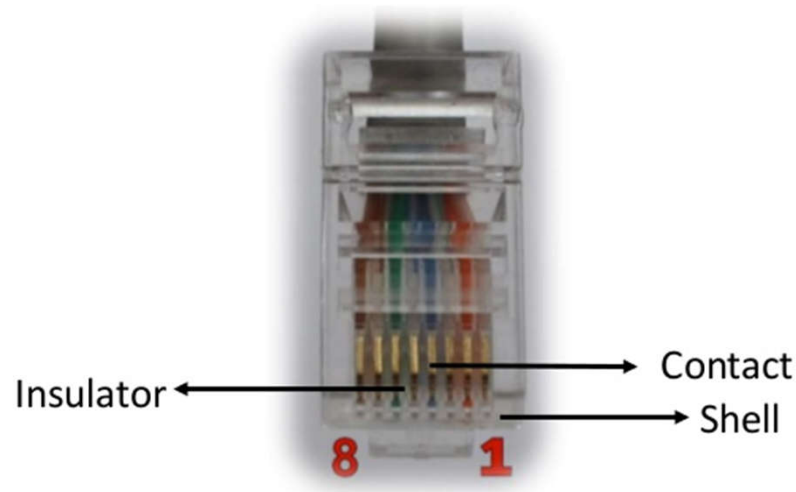
- The **EIA (Electronic Industry Association)** has established standards of twisted-pair cable.
  - **Cat 1, 2, 3, 4, 5** are outdated and not used in any modern LAN network.
  - **Cat 7** is still a new technology and not commonly used.
  - **Cat 5e, 6, 6a** are the commonly used twisted-pair cables.

# Twisted-Pair Cable (Cont'd)

Category	Maximum supported speed	Description
Cat 1	Up to 1Mbps	This cable contains only two pairs (4 wires). This cable was used in the telephone network for voice transmission.
Cat 2	Up to 4Mbps	This cable and all further cables have a minimum of 8 wires (4 pairs). This cable was used in the token-ring network.
Cat 3	Up to 10Mbps	This is the first Ethernet cable that was used in LAN networks.
Cat 4	Up to 20Mbps	This cable was used in advanced Token-ring networks.
Cat 5	Up to 100Mbps	This cable was used in advanced (fast) LAN networks.
Cat 5e	Up to 1000Mbps	This cable is the minimum requirement for all modern LAN networks.
Cat 6	Up to 10Gbps	This cable uses a plastic core to prevent cross-talk between twisted-pair. It also uses a fire-resistant plastic sheath.
Cat 6a	Up to 10Gbps	This cable reduces attenuation and cross-talk. This cable also potentially removes the length limit. This is the recommended cable for all modern Ethernet LAN networks.

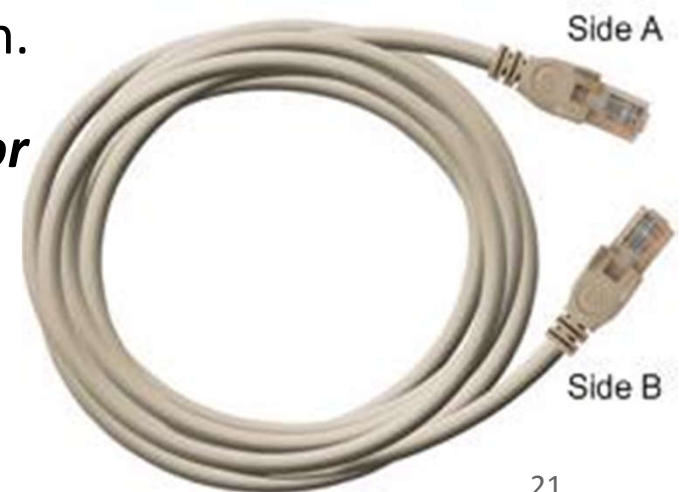
# Twisted-Pair Cable Connector

- The standard connector for twisted-pair cabling is an **RJ-45 connector**
  - RJ stands for Registered Jack
  - An 8-pin connection used for Ethernet network
  - A plastic connector that looks like ordinary phone jacks (RJ-11)
  - The **RJ-45** is a keyed connector, meaning the connector can be inserted in only one way.



# Crimping Twisted-Pair Cable

- Two types of Ethernet network cable are **straight through** and **crossover** cable.
  - **Straight through** and **Crossover** cable have different wire arrangement for serving different purposes.
  - **Cat 5, Cat 5e** or **Cat 6** UTP cable
  - Made of 4 pair high performance cable that consists twisted pair conductors that used for data transmission.
  - Both end of cable is called **RJ-45 connector**



# Crimping Twisted-Pair Cable (Cont'd)

## Straight Through Cable

- Used to connect different type of devices and used most of the time
  1. Connect a **computer** to a **switch/hub's normal port**.
  2. Connect a **computer** to a **cable/DSL modem's LAN port**.
  3. Connect a **router's WAN port** to a **cable/DSL modem's LAN port**.
  4. Connect a **router's LAN port** to a **switch/hub's uplink port**.  
(normally used for expanding network)
  5. Connect **2 switches/hubs** with one of the switch/hub using an **uplink port** and the other one using **normal port**.
    - **Uplink port** special port that eliminates the need of crossover cable

# Crimping Twisted-Pair Cable (Cont'd)

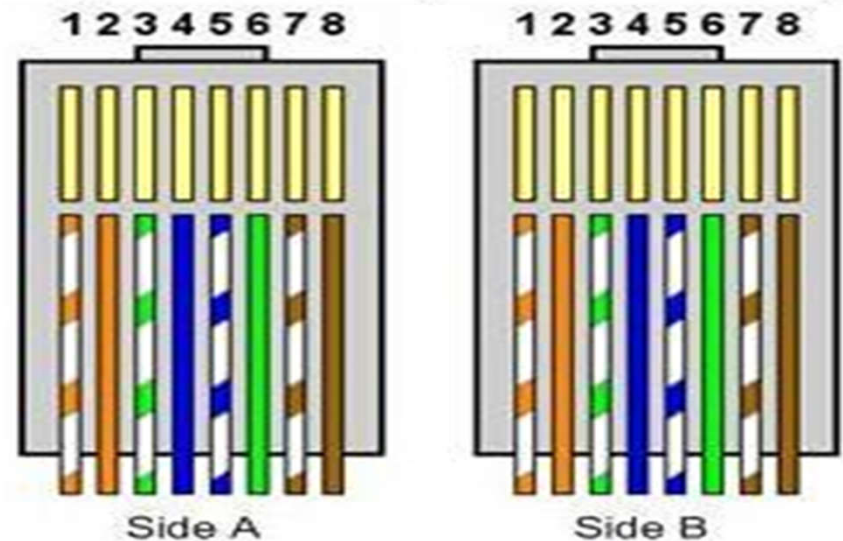
## Straight Through Cabling Standard

- Both side (side A and side B) of cable have wire arrangement with same color.
- Clip is pointed away from you



Clip is pointed away from you.

Pin ID	Side A	Side B
1	White-Orange	White-Orange
2	Orange	Orange
3	White-Green	White-Green
4	Blue	Blue
5	White-Blue	White-Blue
6	Green	Green
7	White-Brown	White-Brown
8	Brown	Brown



# Crimping Twisted-Pair Cable (Cont'd)

## Crossover cable

- Used to connect same type of devices without a switch or hub.
  - Connect **2 computers** directly
  - Connect **a router's LAN port** to **a switch/hub's normal port** (normally used for expanding network)
  - Connect 2 **switches/hubs** by using **normal port** in both switches/hubs



# Crimping Twisted-Pair Cable (Cont'd)

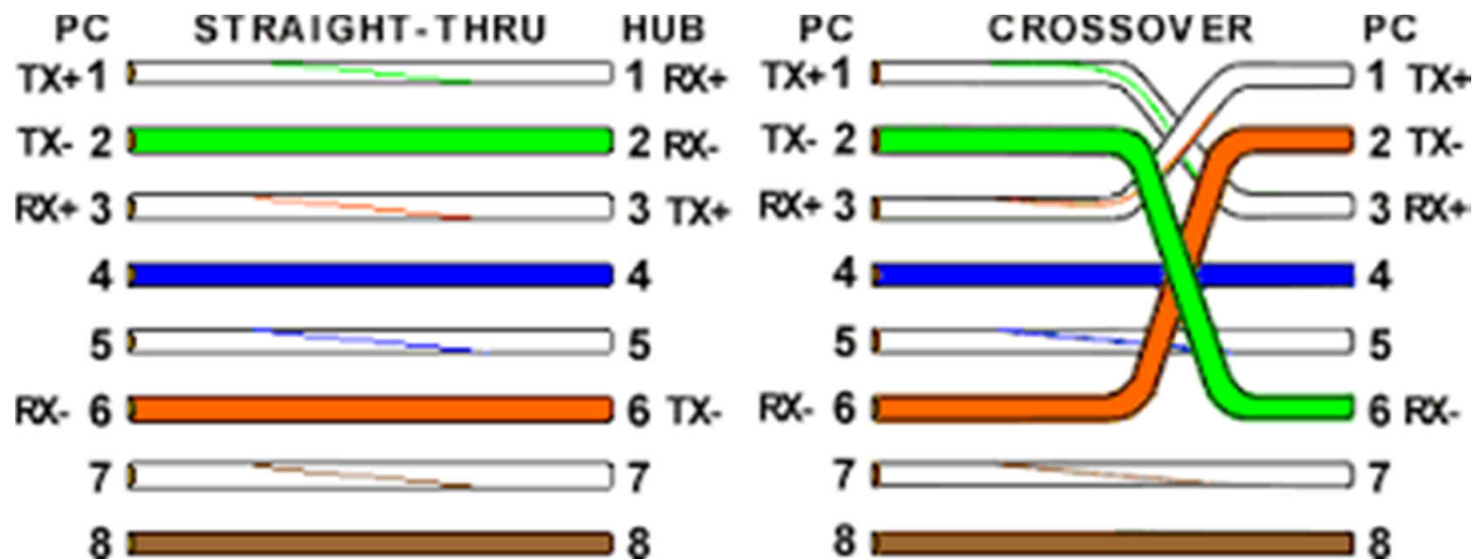
## Crossover Cabling Standard

- Crossover cables *have different ends*
- Both side (side A and side B) of cable have wire arrangement with following different color

Pin ID	Side A	Side B
1	White Orange	White Green
2	Orange	Green
3	White Green	White Orange
4	Blue	Blue
5	White blue	White Blue
6	Green	Orange
7	White Brown	White Brown
8	Brown	Brown

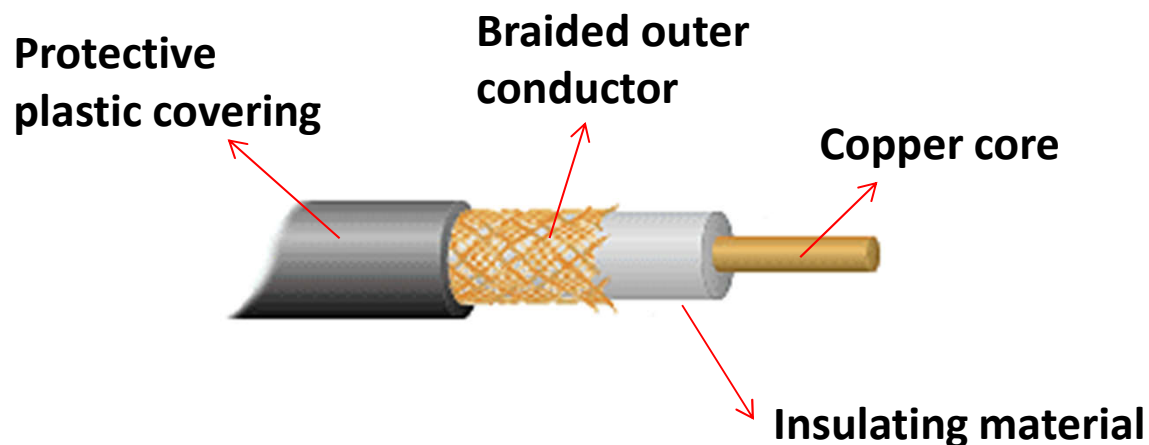
# Crimping Twisted-Pair Cable (Cont'd)

- **Straight through** cables have identical ends and are used for connecting computers through a hub/switch
- **Crossover** cables have different ends and are used for connecting devices directly with each other (e.g. PC to PC)



# Coaxial Cable

- Coaxial cable has a single copper conductor at its center.
- Coaxial cable can support greater cable lengths between network devices than twisted pair cable.
- Although coaxial cabling is difficult to install, it is highly resistant to signal interference.
  - The **braided metal shield** helps to block any outside interference from fluorescent lights, motors, and other computers.
  - A **plastic layer** provides insulation between the center conductor and a **braided metal shield**



# Coaxial Cable\_(Cont'd)

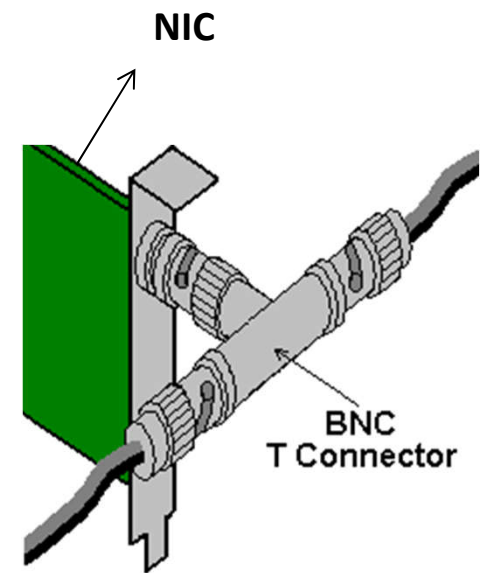
- The two types of coaxial cables
  1. **Thin coaxial cable** is also referred to as thinnet
    - **10Base2** refers to the specifications for thin coaxial cable carrying Ethernet signals.
    - The 2 refers to the approximate maximum segment length being 200 meters. In actual fact the maximum segment length is 185 meters
    - Thin coaxial cable is popular in school networks, especially linear bus networks
  2. **Thick coaxial cable** is also referred to as thicknet
    - Thick coaxial cable has an extra protective plastic cover that helps keep moisture away from the center conductor
    - This makes thick coaxial a great choice when running longer lengths in a linear bus network
    - One disadvantage of thick coaxial is that it does not bend easily and is difficult to install

# Coaxial Cable (Cont'd)

2. **Thick coaxial cable** is also referred to as thicknet
  - **10Base5** refers to the specifications for thick coaxial cable carrying Ethernet signals.
  - The 5 refers to the maximum segment length being 500 meters. Thick coaxial cable has an extra protective plastic cover that helps keep moisture away from the center conductor.

# Coaxial Cable Connectors

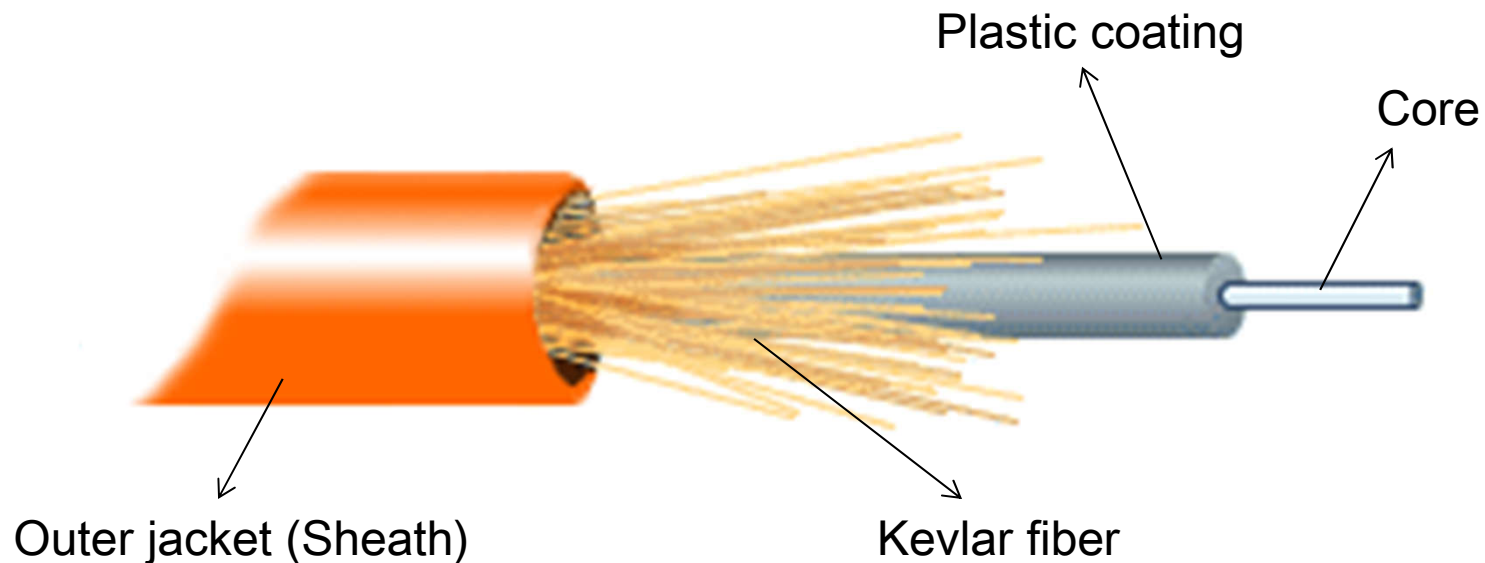
- The most common type of connector used with coaxial cables is the ***Bayonet Neill–Concelman (BNC)*** connector.
- Different types are available for BNC connectors, including a T-connector, barrel connector, e.t.c.



**BNC T-Connector**

# Fiber Optic Cable

- Fiber optic cabling consists of a center glass core surrounded by several layers of protective materials.
  - Outer insulating jacket is made of Teflon or PVC.
  - Kevlar fiber helps to strengthen the cable and prevent breakage.
  - A plastic coating is used to cushion the fiber center.
  - Center (core) is made of glass or plastic fibers.



## Fiber Optic Cable (Cont'd)

- Transmits light rather than electronic signals eliminating the problem of electrical interference.
- Used to connect networks between buildings, due to its immunity to the effects of moisture and lightning.
- Has the ability to transmit signals over much longer distances than coaxial and twisted-pair.
- Has the capability to carry information at vastly greater speeds.
- This capacity broadens communication possibilities to include services such as video conferencing and interactive services.
- The cost of fiber optic cabling is a little bit higher; and, it is more difficult to install and modify.

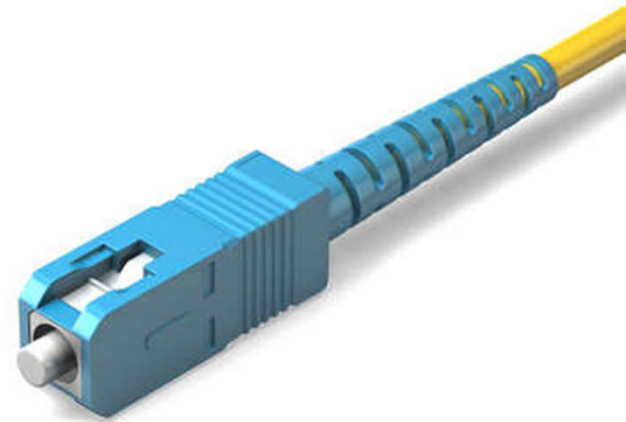


# Fiber Optic Connector

- There are many connectors used with fiber optic cable such as an **ST** and **SC** connector.
  - The **ST** is barrel shaped, similar to a BNC connector.
  - The **SC** has a squared face and is easier to connect in a confined space.



**ST connector**



**SC connector**