COMPUTER NETWORK: DAY 2

- Guided & Unguided Transmission Medium
- Networking Devices

TRANSMISSION MEDIA

- Definition: Anything that can carry information from source to destination
- E.g. air, metallic cable, fiber optic cable
- Transmission Medium in Telecom:
  - ✓ Guided-provides conduit from one device to another
  - ✓ Unguided-transport electromagnetic waves without using physical conductor

GUIDED MEDIUM

- Twisted pair cable
- Coaxial Cable
- Fiber Optic cable

TWISTED PAIR CABLE

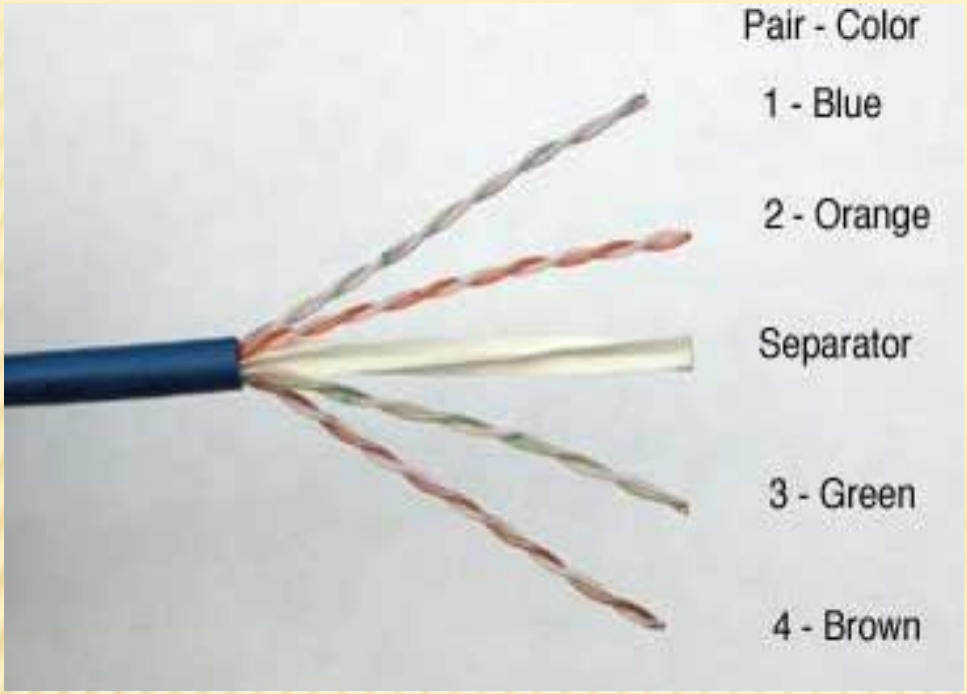
- Two insulated copper wires arranged in a regular spiral pattern.
- A wire pair acts as a single communication link.
- A number of these pairs are bundled together into a cable by wrapping them in a tough protective sheath.
- Least expensive.
- Most widely used.

—Separately insulated
—Twisted together
—Often "bundled" into cables
—Usually installed in building during construction

(a) Twisted pair

UTP & STP

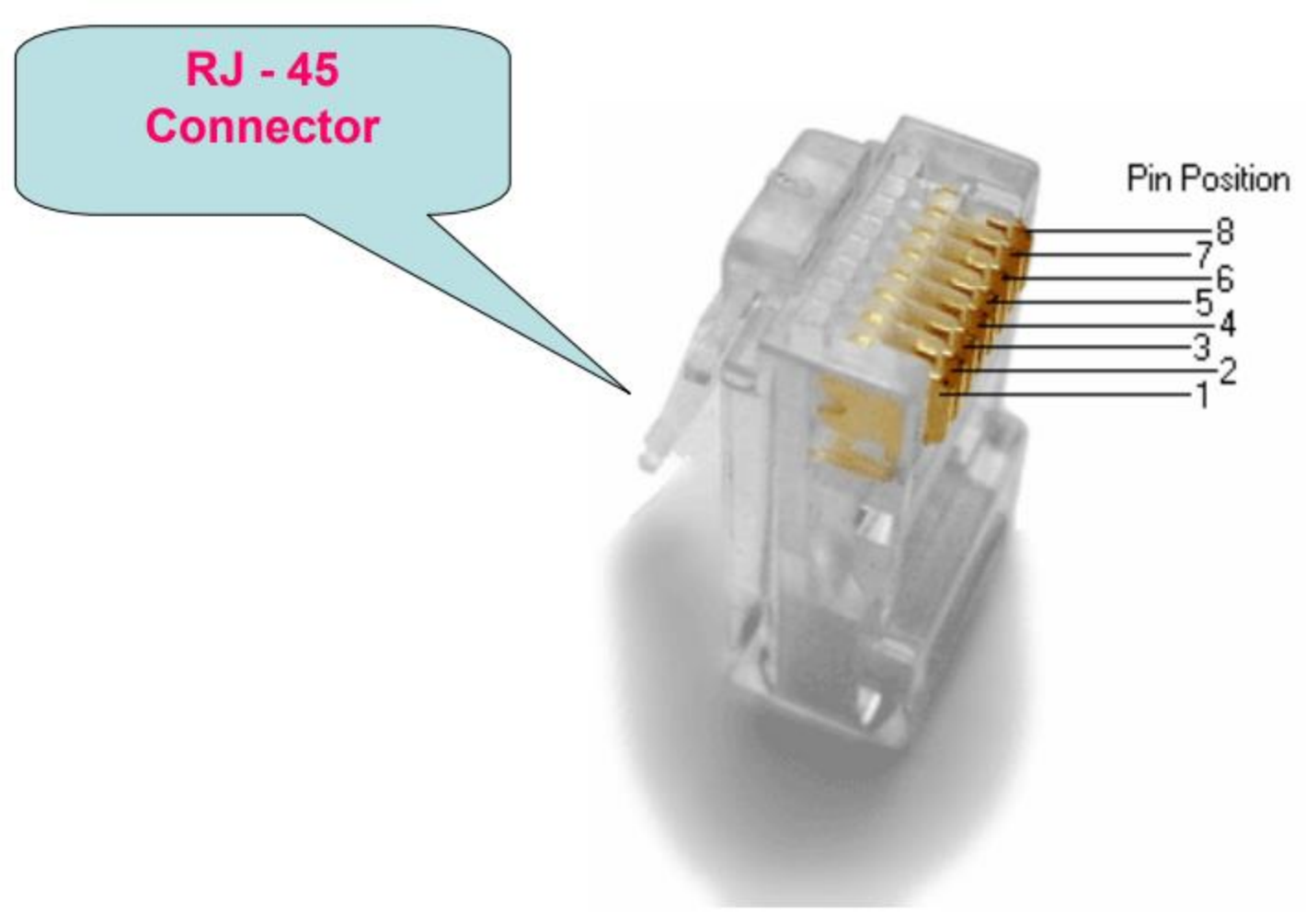
- Unshielded Twisted Pair (UTP)- 7 categories. Used with RJ45 connector.
- Shielded Twisted Pair (STP)


Pair - Color
1 - Blue
2 - Orange
Separator
3 - Green
4 - Brown

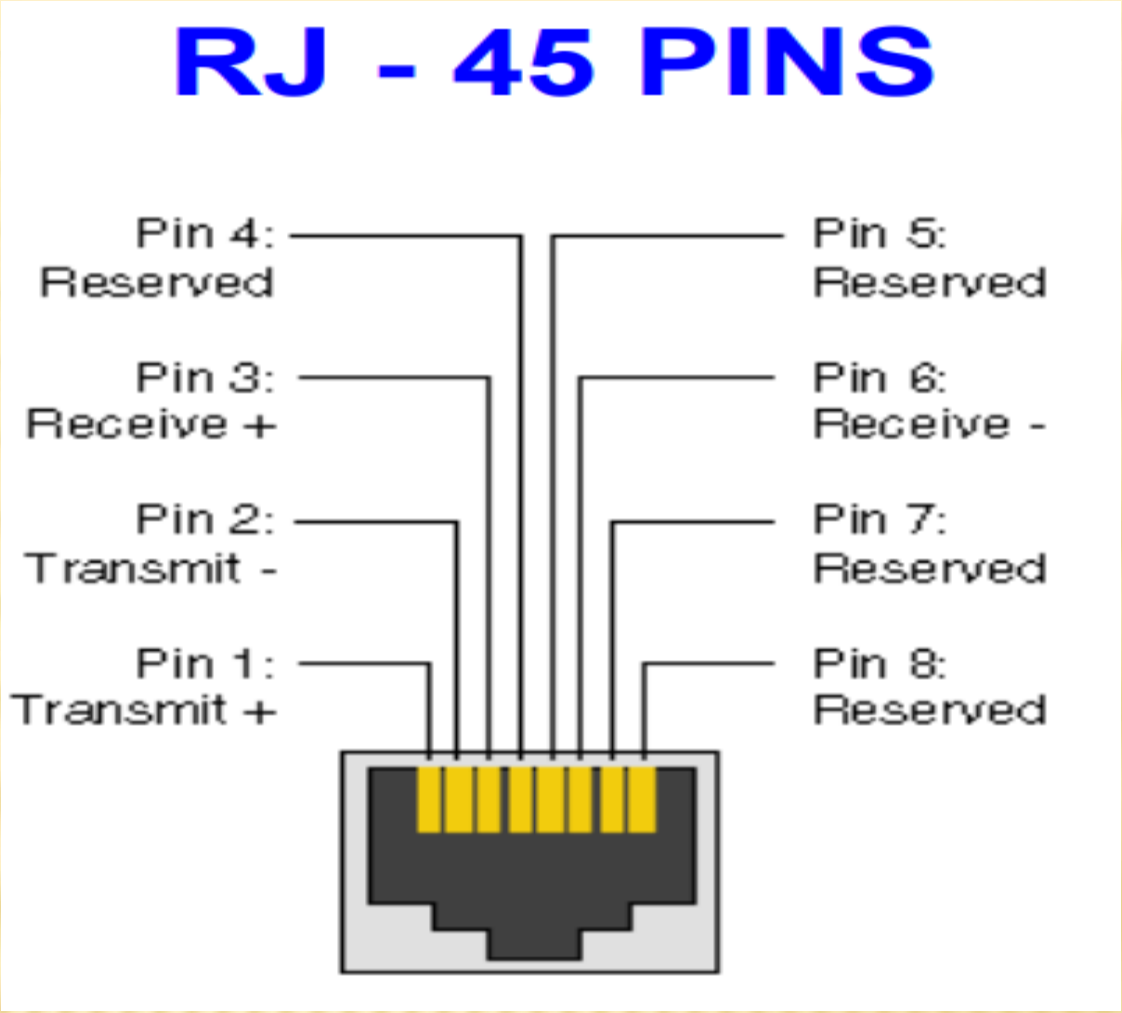
UTP Categories - Copper Cable

UTP Category	Data Rate	Max. Length	Cable Type	Application
CAT1	Up to 1Mbps	-	Twisted Pair	Old Telephone Cable
CAT2	Up to 4Mbps	-	Twisted Pair	Token Ring Networks
CAT3	Up to 10Mbps	100m	Twisted Pair	Token Rink & 10BASE-T Ethernet
CAT4	Up to 16Mbps	100m	Twisted Pair	Token Ring Networks
CAT5	Up to 100Mbps	100m	Twisted Pair	Ethernet, FastEthernet, Token Ring
CAT5e	Up to 1 Gbps	100m	Twisted Pair	Ethernet, FastEthernet, Gigabit Ethernet
CAT6	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT6a	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT7	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (100 meters)

UTP CONNECTOR- RJ45



RJ - 45 PINS

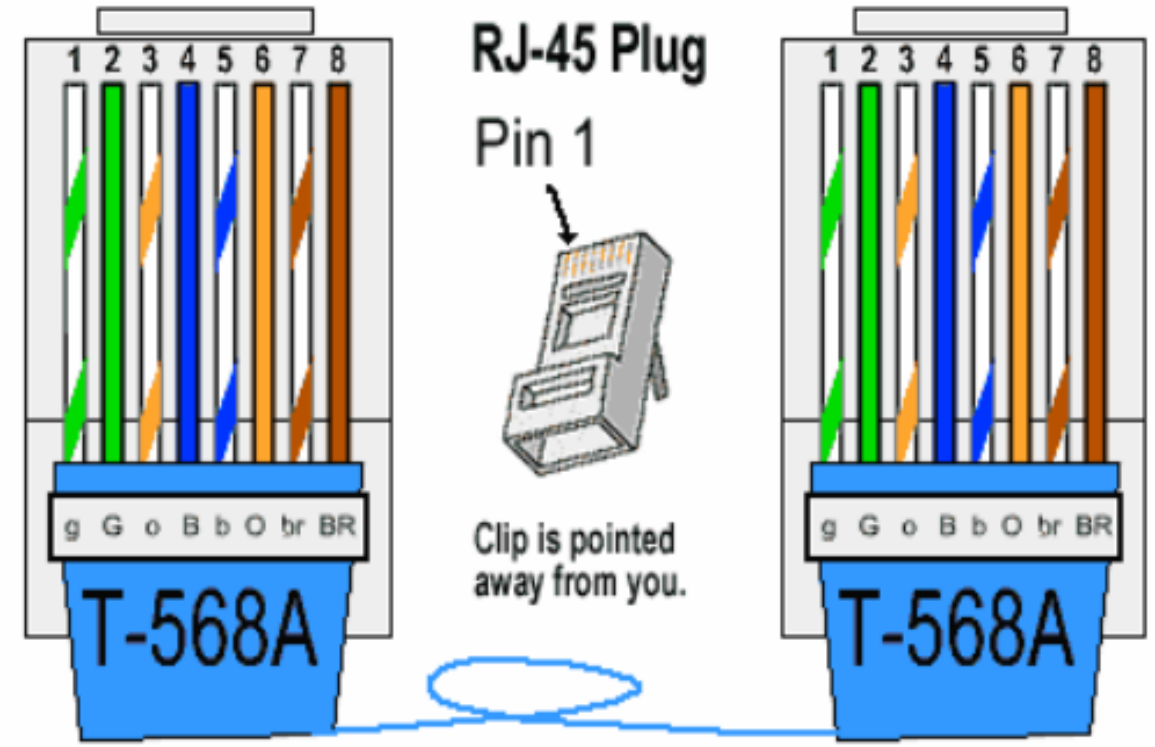


RJ45 Male: Plug
RJ45 Female: Jack
Patch Cable

STRAIGHT CABLE

- Used to connect different type of devices.
- **Both side (side A and side B) of cable have wire arrangement with same color.**
- T-568A Straight-Through Ethernet Cable
- T-568B Straight-Through Ethernet Cable

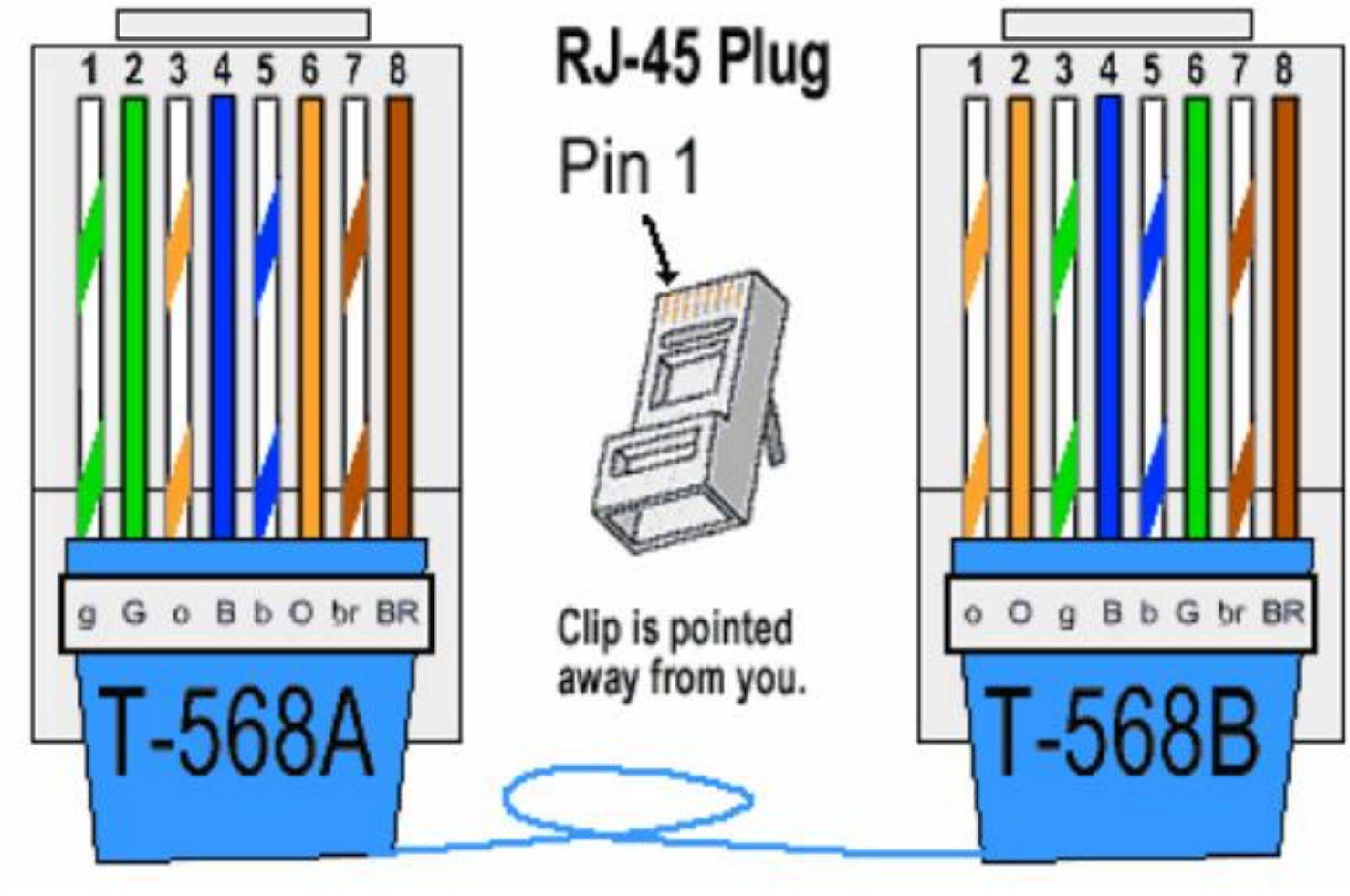
T-568A
Straight-Through Ethernet Cable



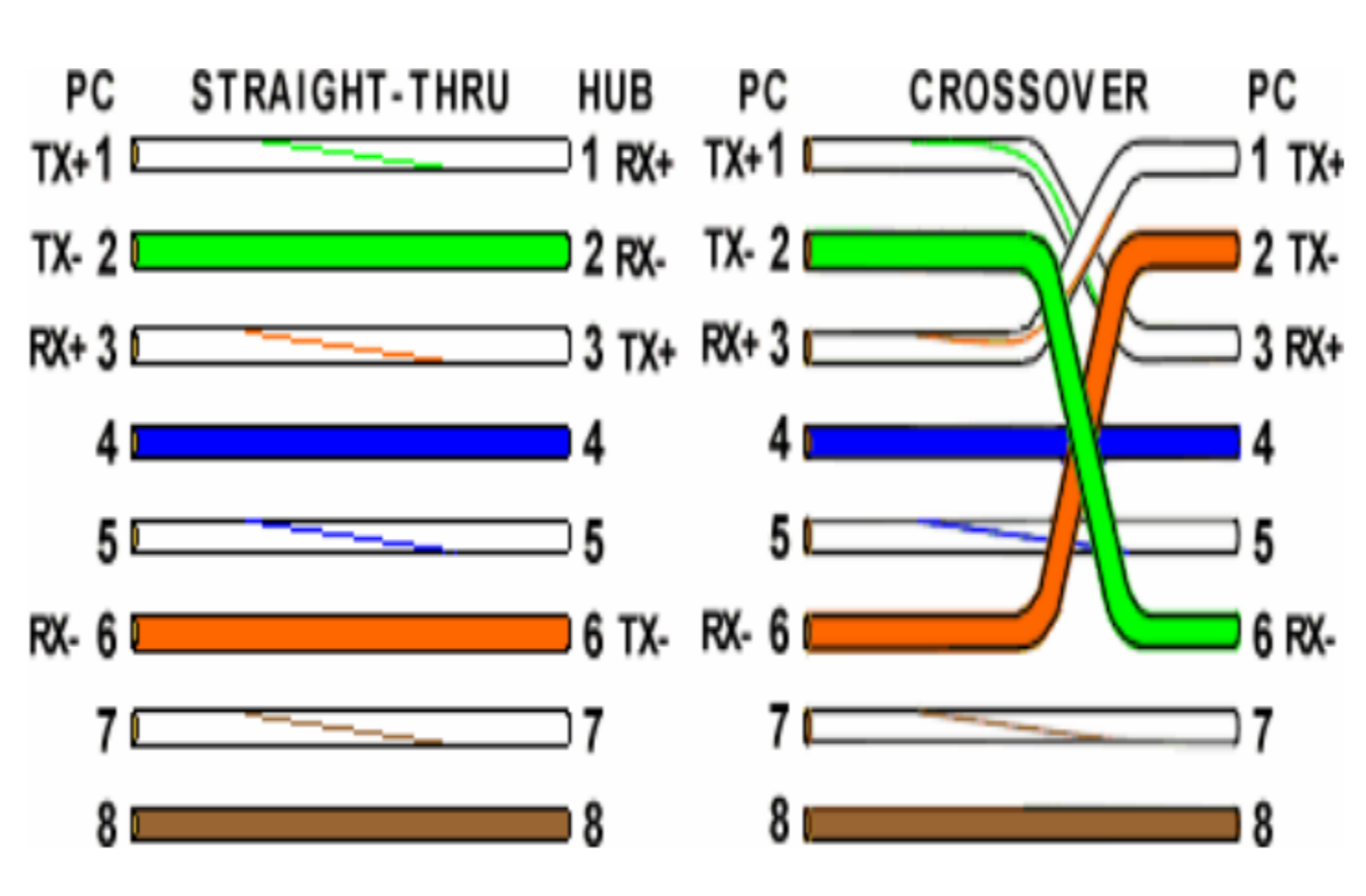
CROSSOVER CABLE

- Used to connect same type of devices.
- **Both side (side A and side B) of cable have wire arrangement with following different color.**
- Cross over cable using T-568 A &m T-568B.

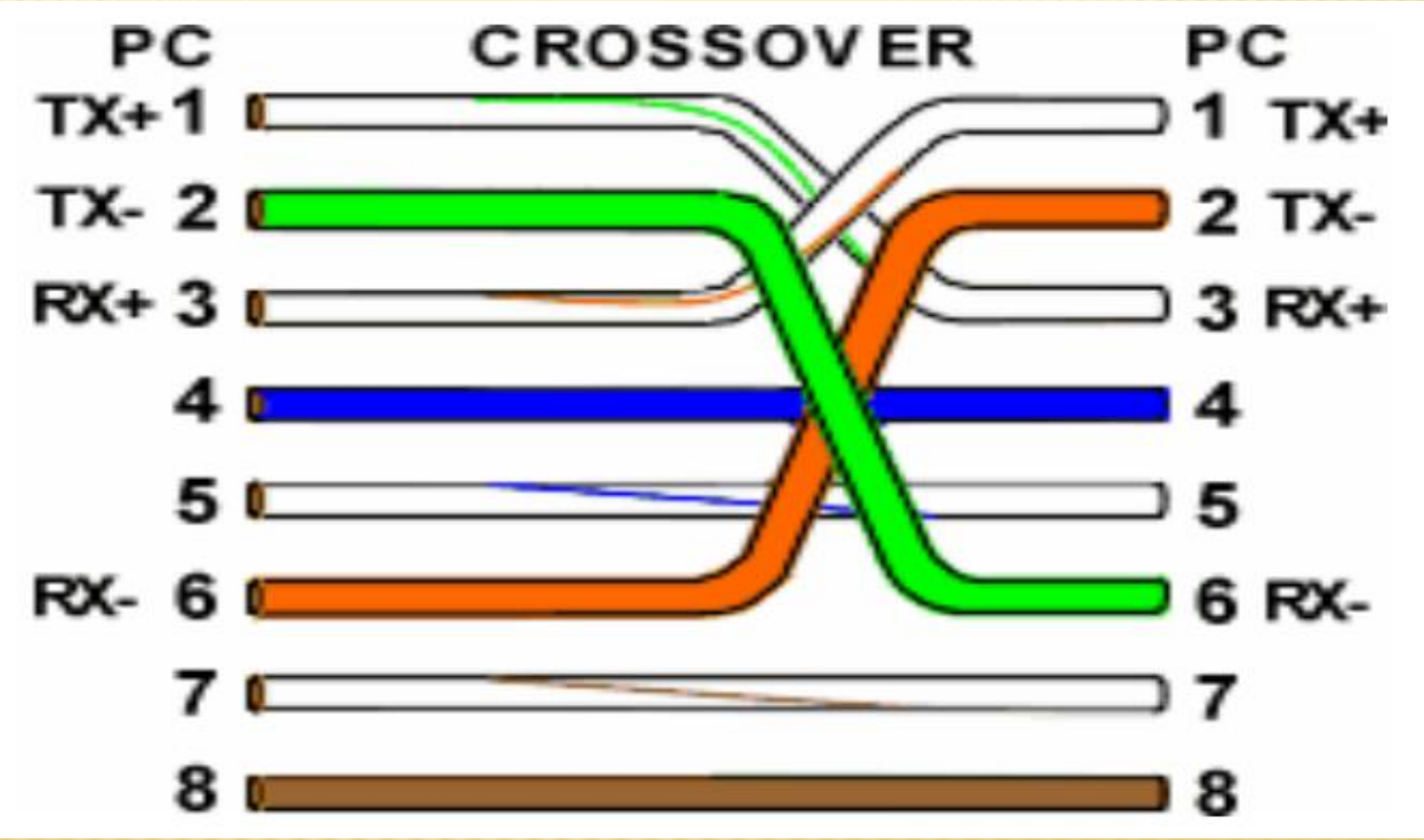
RJ-45 Crossover Ethernet Cable



BASIC THEORY



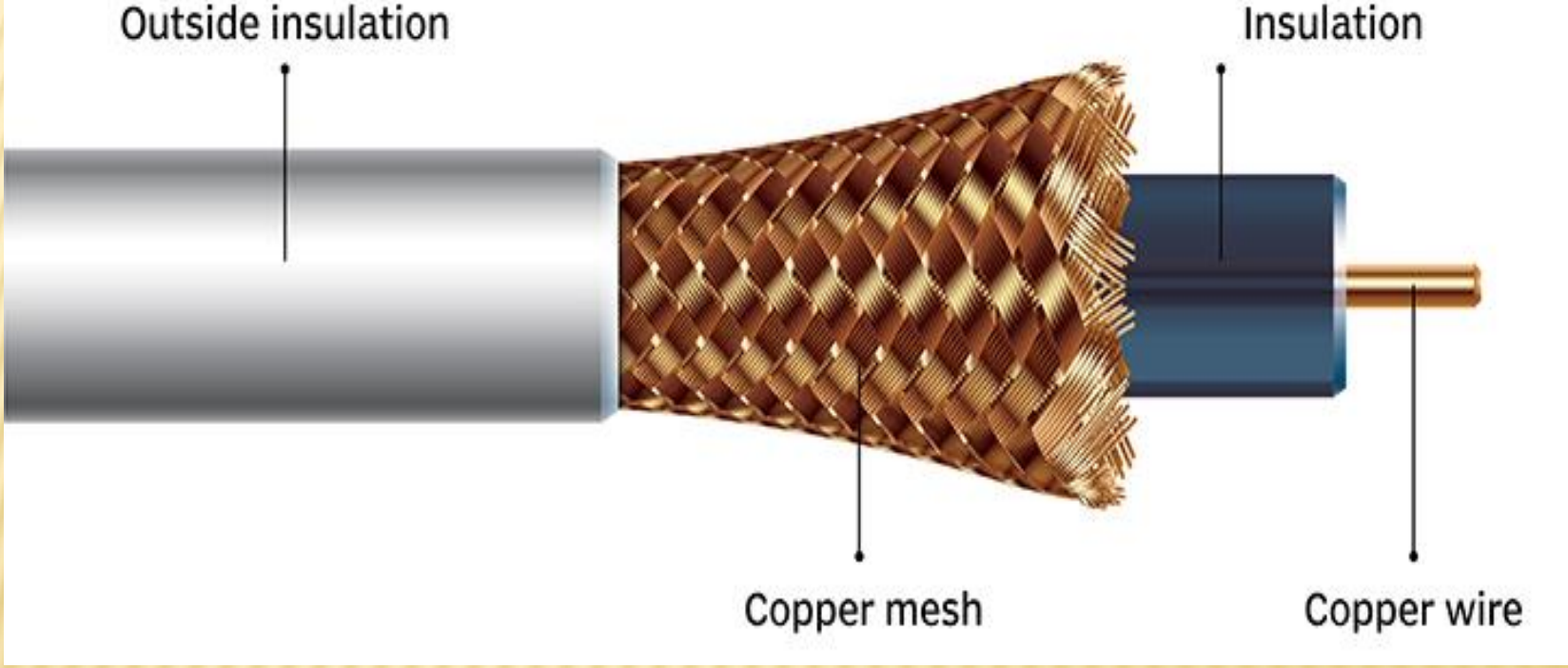
CROSS OVER CRIMPING



COAXIAL CABLE

- Type of copper cable specially built with a metal shield and other components engineered to block signal interference.
- Used by cable TV companies to connect their satellite antenna facilities to customer homes and businesses.
- Also sometimes used by telephone companies to connect central offices to telephone poles near customers.

Coaxial cable



COAXIAL CABLE- STRUCTURE

- Coax cables have concentric layers of electrical conductors and insulating material.
- This ensures signals are enclosed within the cable and prevents electrical noise from interfering with the signal.
- Center conductor layer is a thin conducting wire, either solid or braided copper.
- A dielectric layer, made up of an insulating material with very well-defined electrical characteristics, surrounds the wire.
- A shield layer then surrounds the dielectric layer with metal foil or braided copper mesh.
- The whole assembly is wrapped in an insulating jacket.
- The outer metal shield layer of the coax cable is typically grounded in the connectors at both ends to shield the signals and as a place for stray interference signals to dissipate.

THICK COAX

- **Thick coaxial cable:** specified by the IEEE 802.3 10Base5 standard
- Cable has an average diameter of 12mm
- Usually colored yellow
- Referred to as a standard ethernet/ thick Ethernet/ ThickNet/ yellow cable.

THICK COAX

- Maximum of three segments with the connected equipment (attached devices) or apopulated segments.
- Each segment contains a maximum of 100 network devices, including repeaters in this case.
- Maximum cable length per segment is 1640 feet (or about 500 meters).

THIN COAX

- Widely used in amateur radio circles, especially for the transceiver that does not require a large power output.
- To be used as network devices, this type of coaxial cable must meet the standards of IEEE 802.3 10BASE2 (i.e. average diameter of about 5mm and usually black or other dark colors).
- Each device connected to a BNC T-connector.
- The cable type is also known as thin Ethernet/ thinnet.

THIN COAX

- The maximum length of cable is 1,000 feet (185 meters) per segment.
- Each segment is a maximum of 30 network devices (devices)
- Maximum there are 3 segments connected to each other (populated segments).
- Minimum length among the T-Connector is 1.5 feet (0.5 meters).
- Maximum cable length in one segment is 1.818 feet (555 meters).

THIN COAX

BNC CONNECTORS

- BNC (Bayonet Neill–Concelman) connector is a miniature quick connect / disconnect radio frequency connector used for coaxial cable.
- It features two bayonet lugs on the female connector.
- Mating is fully achieved with a quarter turn of the coupling nut.
- BNC, is used for the thin coaxial cable or Thinnet.

BNC CONNECTORS

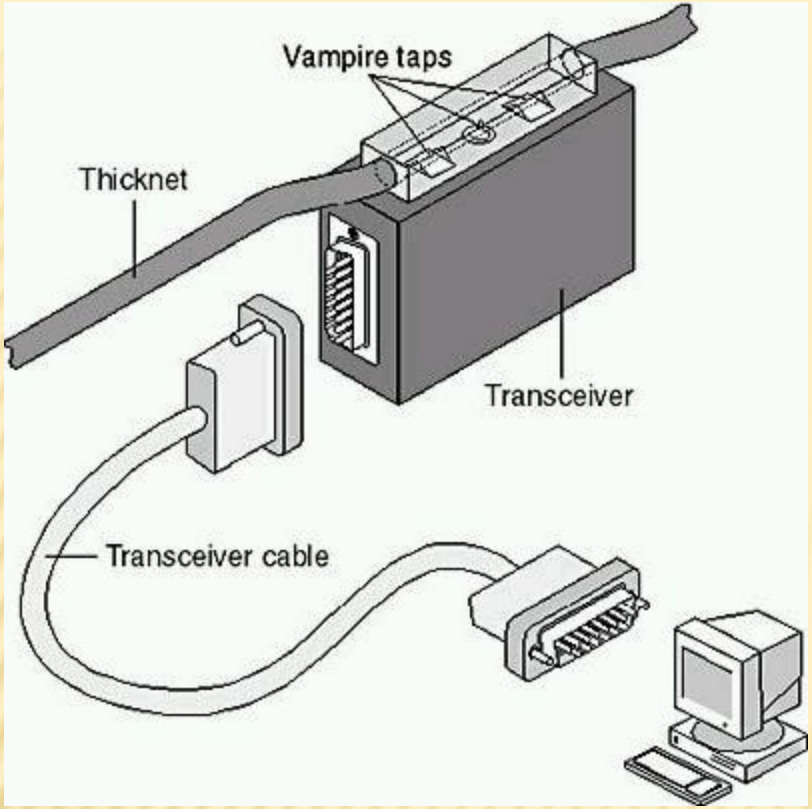
T-CONNECTORS

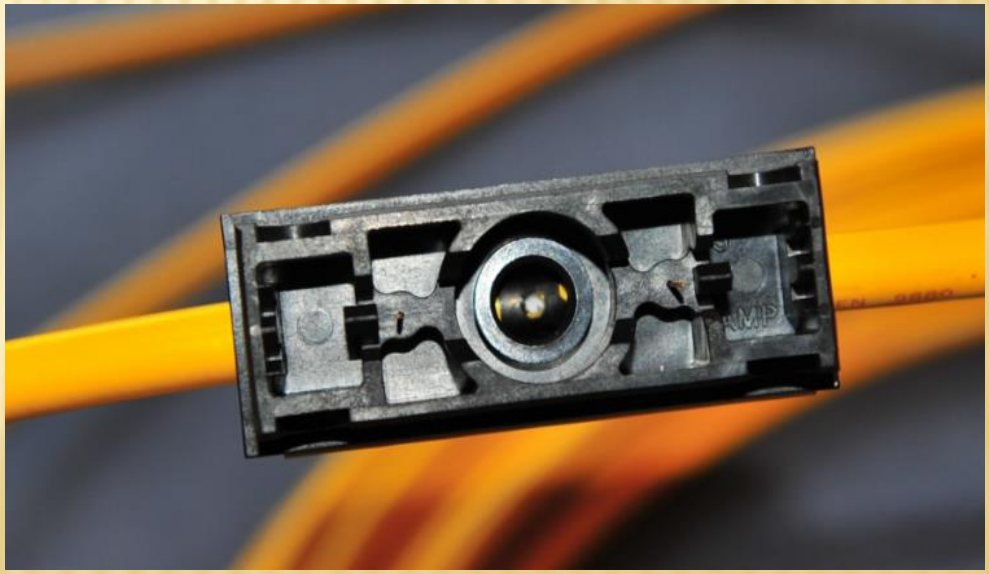
- A tee connector is an electrical connector that connects three cables together.
- It is usually in the shape of a capital T.
- Used for coax cables and the three connector points can be either female or male gender, and could be different or the same standard, such as F type, BNC or N type.
- Tee connectors can be used to split radio frequency power from a cable into two.
- It could be used to attach a piece of electronic test equipment.
- T connectors were much used on co-axial 10M Ethernet networks.

T-CONNECTORS

COAXIAL TAP-IN (VAMPIRE TAP) CONNECTOR

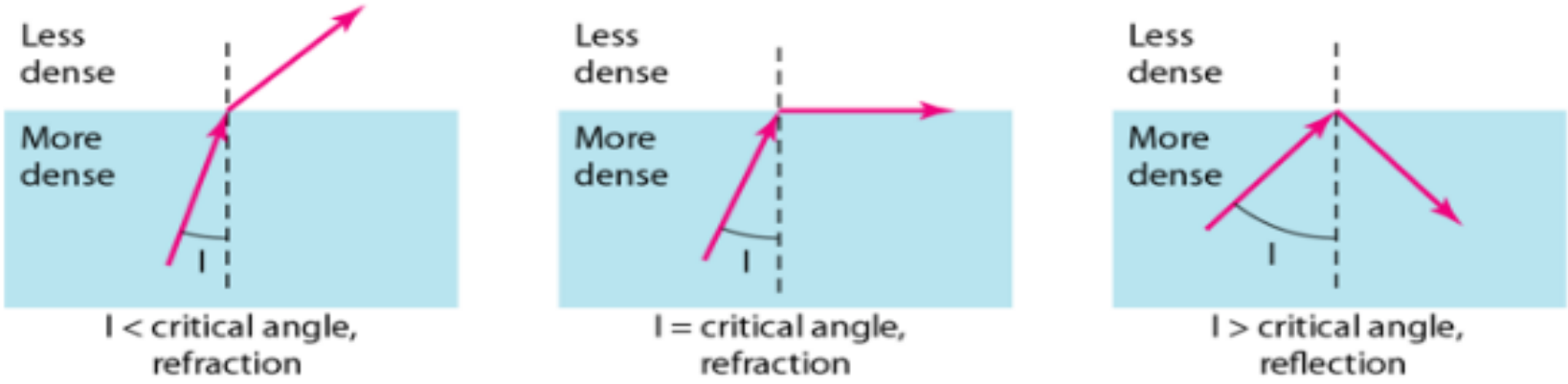
- A vampire tap is a connection to a coaxial cable in which a hole is drilled through the outer shield of the cable so that a clamp can be connected to the inner conductor of the cable.
- It's a tap-in connector that allows one to simply “tap-in” to the coaxial cable without the use of splitters or connectors, so installation is completed easily and efficiently without any disruption to service.
- A vampire tap is **used** to connect each device to **Thicknet coaxial cable** in the bus topology of an Ethernet 10BASE-T local area network.


Vampire taps
Thicknet
Transceiver
Transceiver cable

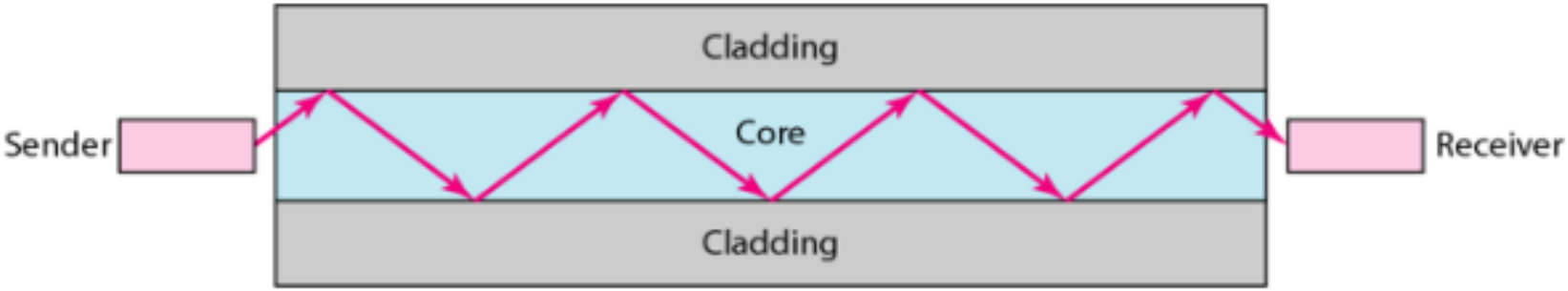


FIBER OPTIC CABLE

- A fibre-optic cable is made of glass or plastic and transmits signals in the form of light.
- Light travels in a straight line as long as it is moving through a single uniform substance.
- If ray of light travelling through one substance suddenly enters another substance (of a different density), the ray changes direction.
- Optical fibres use reflection to guide light through a channel.
- A glass or plastic core is surrounded by a cladding of less dense glass or plastic.
- The difference in density of the two materials must be such that a beam of light moving through the core is reflected off the cladding instead of being refracted into it.



Bending of a light ray



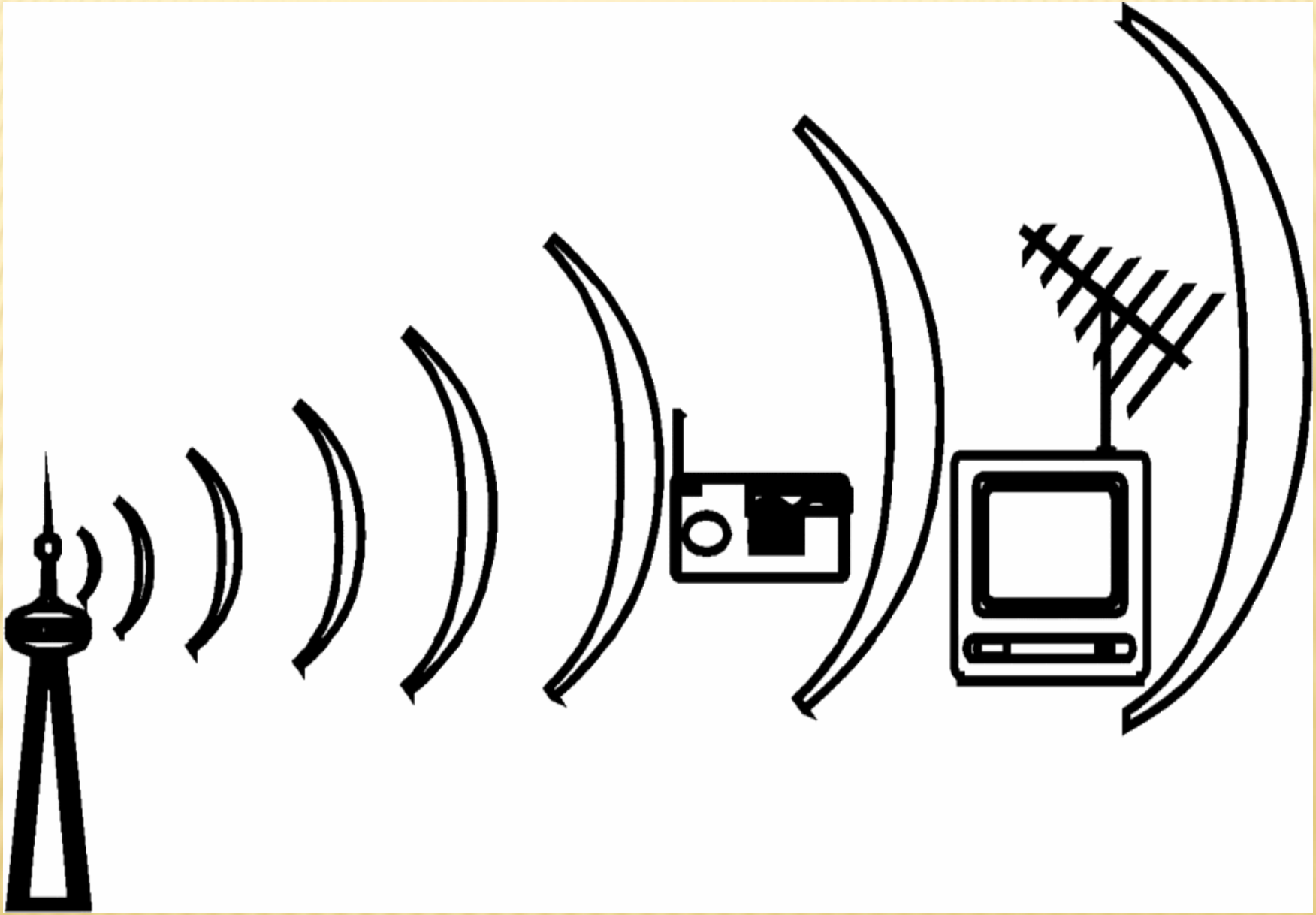
Internal view of an Optical fibre

UNGUIDED MEDIUM

- Radio wave
- Microwave
- Satellite
- Infrared

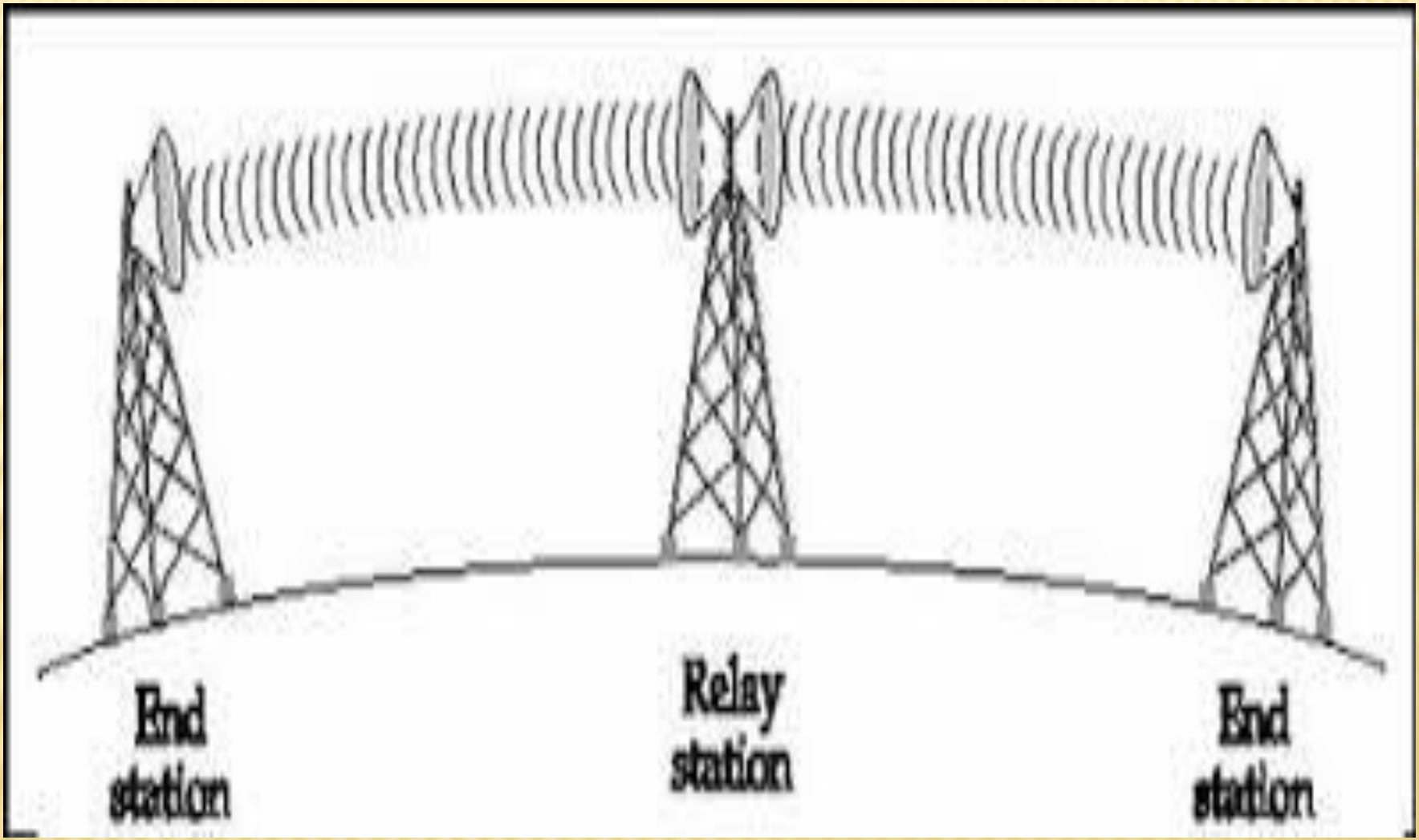
RADIO WAVES

- Electromagnetic waves ranging in frequencies between 3 KHz and 1 GHz are normally called radio waves.
- Radio waves are omnidirectional. Sending and receiving antennas do not have to be aligned.
- Radio waves, particularly with those of low and medium frequencies, can penetrate walls.
- Radio waves are useful for multicasting.
- AM and FM radio, television, maritime radio, cordless phones, and paging are examples of multicasting.



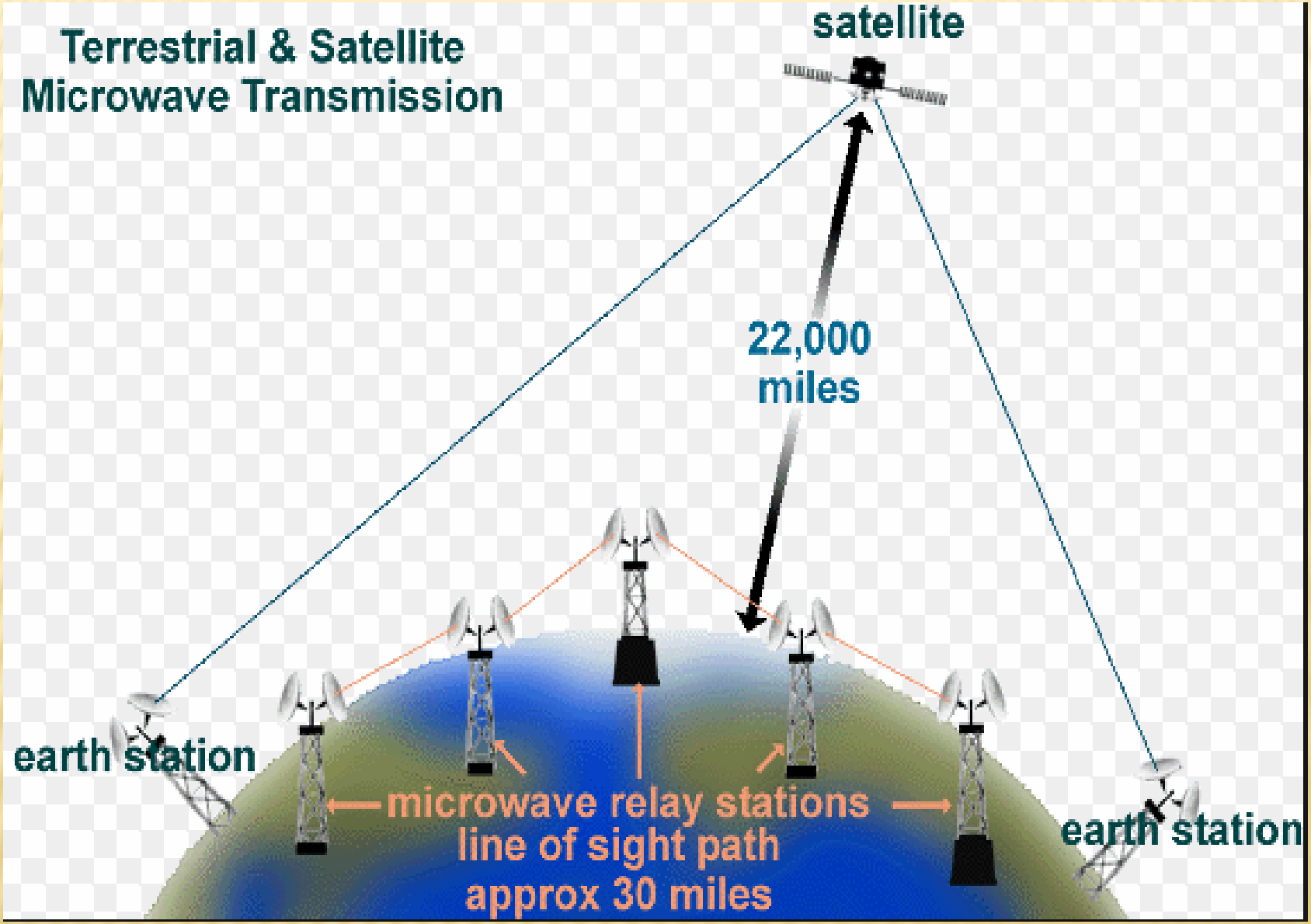
MICROWAVE

- Electromagnetic waves having frequencies between 1 and 300 GHz are called micro waves.
- Micro waves are unidirectional. This means that the sending and receiving antennas need to be aligned.
- Microwaves, due to their unidirectional properties, are very useful when unicast(one-to-one) communication is needed between the sender and the receiver.
- They are used in cellular phones, satellite networks and wireless LANs
- There are 2 types of Microwave Transmission :
  - Terrestrial Microwave
  - Satellite Microwave


End station
Relay station
End station

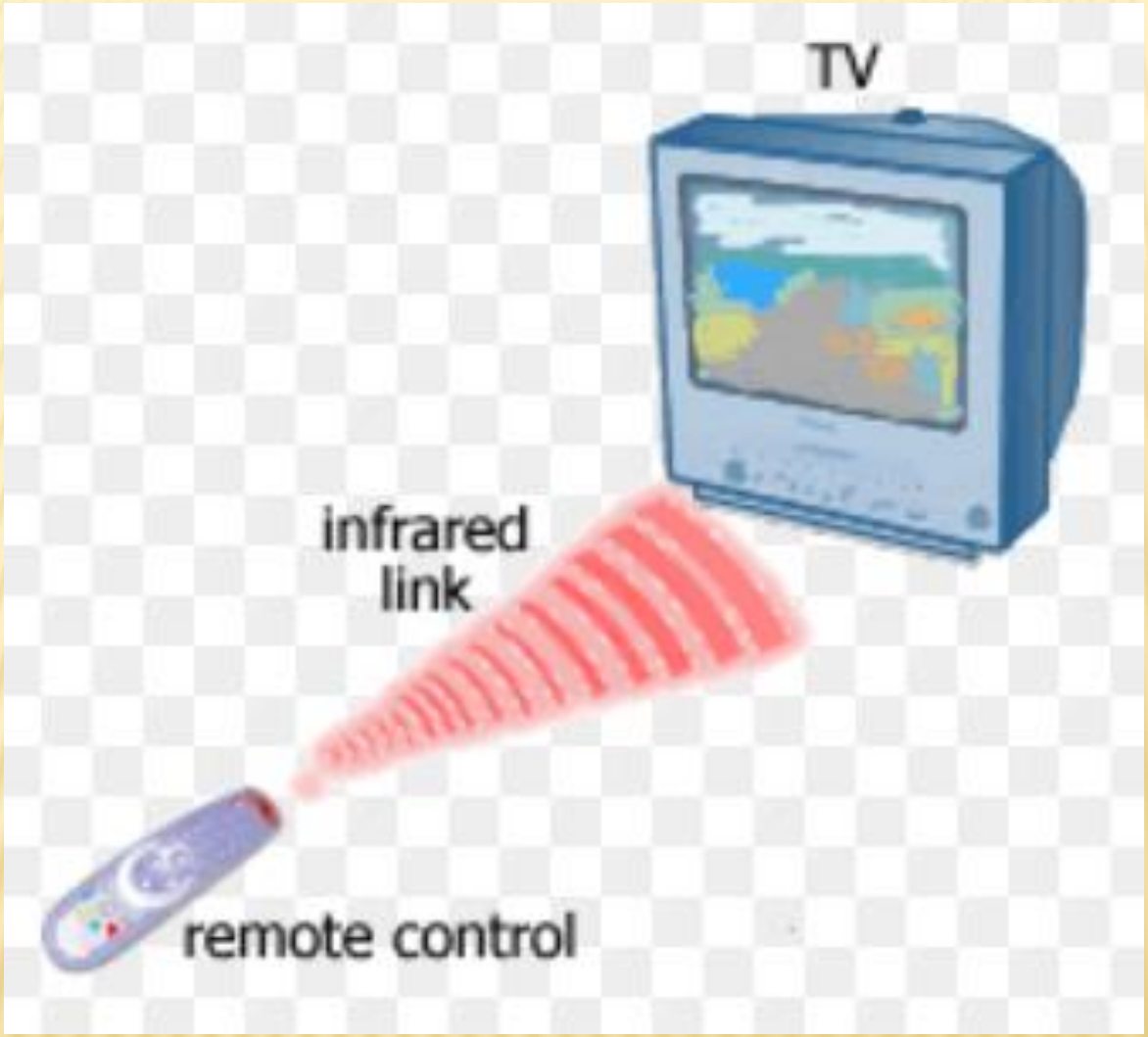
SATELLITE COMMUNICATION

- A communication satellite can be seen as a microwave repeater in space.
- It is equipped with a number of devices called transponders, each of which listens to some portion of the electromagnetic spectrum, amplifies an incoming signal (the uplink), and re-broadcasts it at another frequency (the downlink).
- Geostationary satellites are placed in orbit above the equator at a height and speed that enables them to maintain a position above a specific location on the earth's surface.
- The antenna used to receive signals from these satellites can thus be mounted in a fixed position.
- The downlink signal can be relatively narrowly focused (a *spot-beam*), or may cover a substantial fraction of the earth's surface.
- The area covered by the signal is called its *footprint*.


Terrestrial & Satellite
Microwave Transmission
satellite
22,000
miles
earth station
microwave relay stations
line of sight path
approx 30 miles
earth station

INFRARED

- Infrared waves, with frequencies from 300 GHz to 400 THz, can be used for short-range communication.
- Infrared waves, having high frequencies, cannot penetrate walls.
- Infrared signals are useless for long-range communication.
- We cannot use infrared waves outside a building because the sun's rays contain infrared waves that can interfere with the communication.
- Infrared signals can be used for short-range communication in a closed area using line-of-sight propagation.


TV
infrared
link
remote control

NETWORK DEVICES

- Computer networking devices are known by different names such as networking devices, networking hardware, network equipment etc. However, all of the names mean the same but have got different purposes.

HUBS

- Serves as a central point to which all of the hosts in a network connect to.
- It is an OSI **layer 1** device.
- It receives a signal from one port and sends it out to all other ports.
- Also called a multiport repeater.
- When a host sends a data packet to a network hub, the hub copies the data packet to all of its ports connected to.
- So, all the ports know about the data and the port for whom the packet is intended, claims the packet.
- A hub is not so secure and safe.
- Copying the data packets on all the interfaces or ports makes it slower and more congested which led to the use of network switch.
- They create only one large collision domain. A hub typically operates in half duplex.
- Hub Types: Active (**repeaters**) & Passive

ETHERNET HUBS

- It is a device connecting multiple Ethernet devices together and makes them perform the functions as a single unit.
- They vary in speed in terms of data transfer rate.
- Ether utilizes Carrier Sense Multiple Access with Collision Detect (CSMA/CD) to control Media access.
- Ethernet hub communicates in half-duplex mode where the chances of data collision are inevitable at most of the times.

SWITCH

- Switch does ‘filter and forwarding’ which is a more intelligent way of dealing with the data packets.
- For this purpose, a switch also maintains a CAM (Content Addressable Memory) table and has its own system configuration and memory. CAM table is also called as forwarding table or forwarding information base (FIB).
- Each port on a switch is a separate collision domain and can run in a full duplex mode.
- Switch is an OSI Layer 2 device.

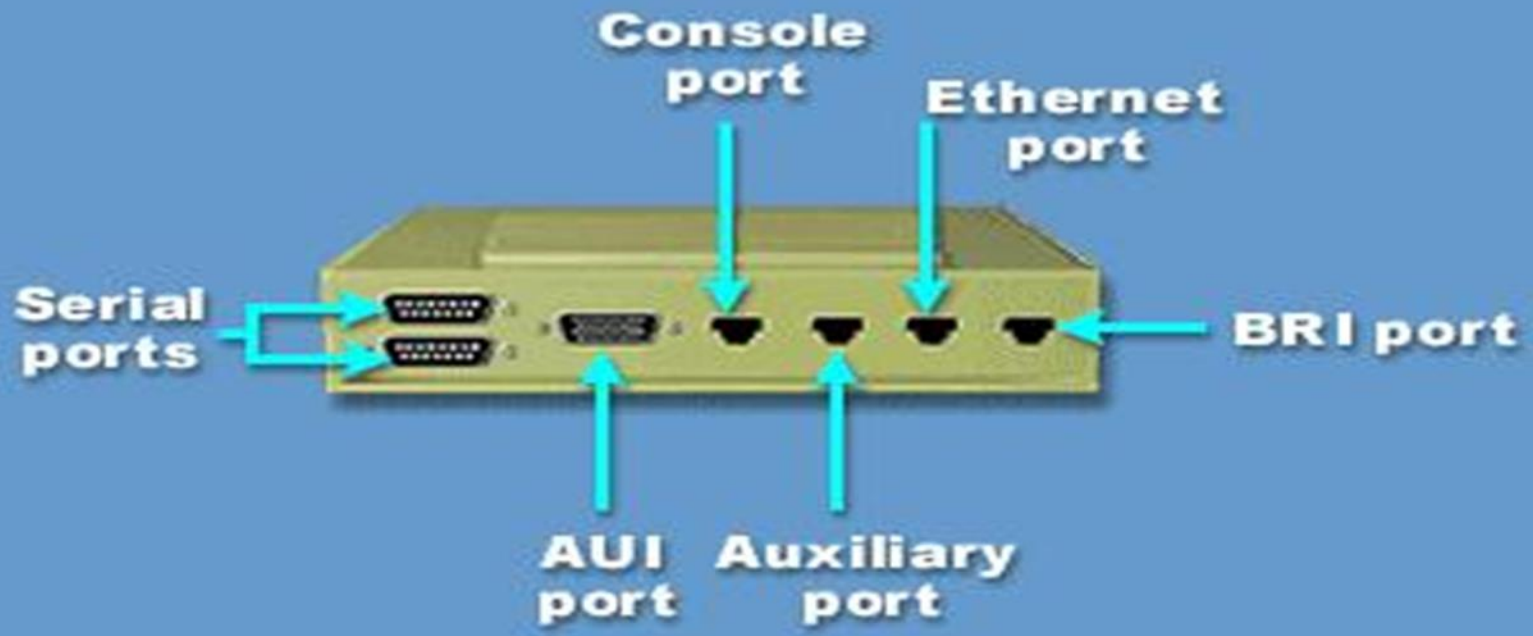
Hub

Switch

ROUTERS

- A router is a device that routes packets from one network to another.
- A router is most commonly an OSI Layer 3 device.
- Routers divide broadcast domains and have traffic filtering capabilities.
- Routers normally connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets.

Router Interfaces



BRIDGE

- A bridge operates at data link layer.
- A bridge is a repeater, with add on functionality of filtering content by reading the MAC addresses of source and destination.
- It is also used for interconnecting two LANs working on the same protocol.
- It has a single input and single output port, thus making it a 2 port device.

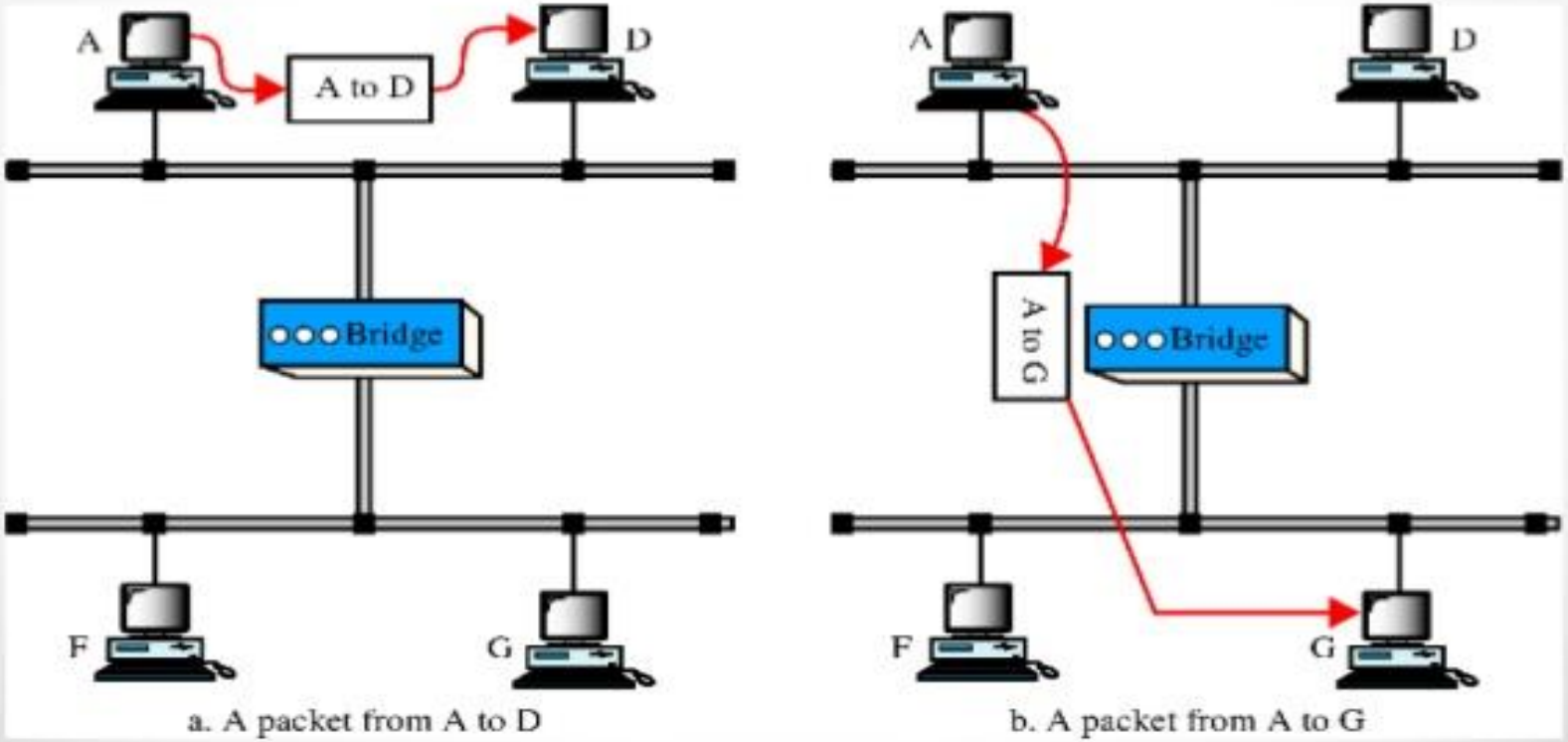
BRIDGE TYPES

- **Transparent bridge** - A transparent bridge is invisible to the other devices on the network. Transparent bridges perform only the function of blocking or forwarding data based on the MAC address; the devices on the network are oblivious to these bridges' existence.

- **Translational bridge** - A translational bridge can convert from one networking system to another. As you might have guessed, it translates the data it receives. Translational bridges are useful for connecting two different networks, such as Ethernet and Token Ring networks. Depending on the direction of travel, a translational bridge can add or remove information and fields from the frame as needed.

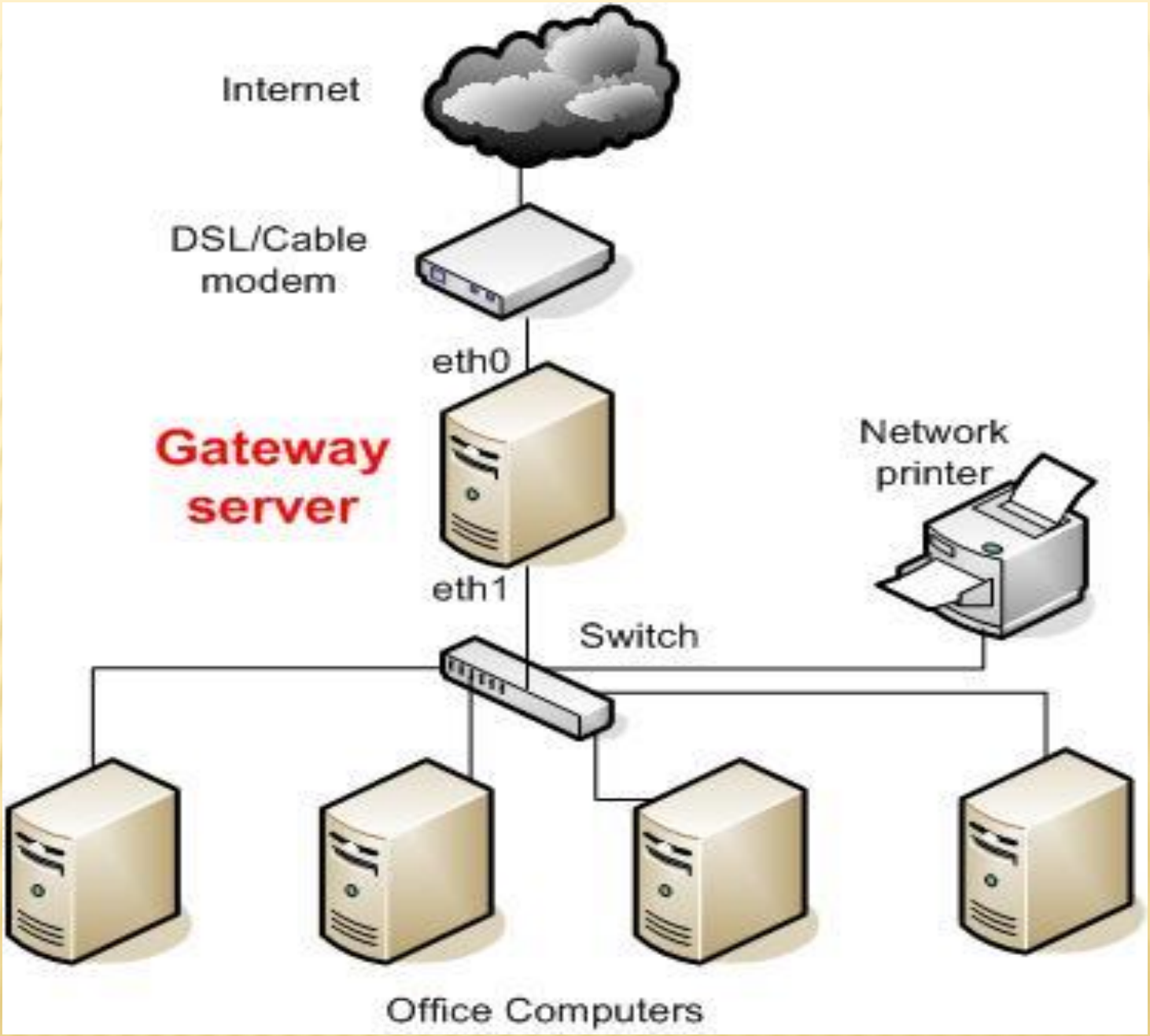
- **Source-route bridge** - Source-route bridges were designed by IBM for use on Token Ring networks. The source-route bridge derives its name from the fact that the entire route of the frame is embedded within the frame. This allows the bridge to make specific decisions about how the frame should be forwarded through the network.

Function of a bridge



GATEWAY

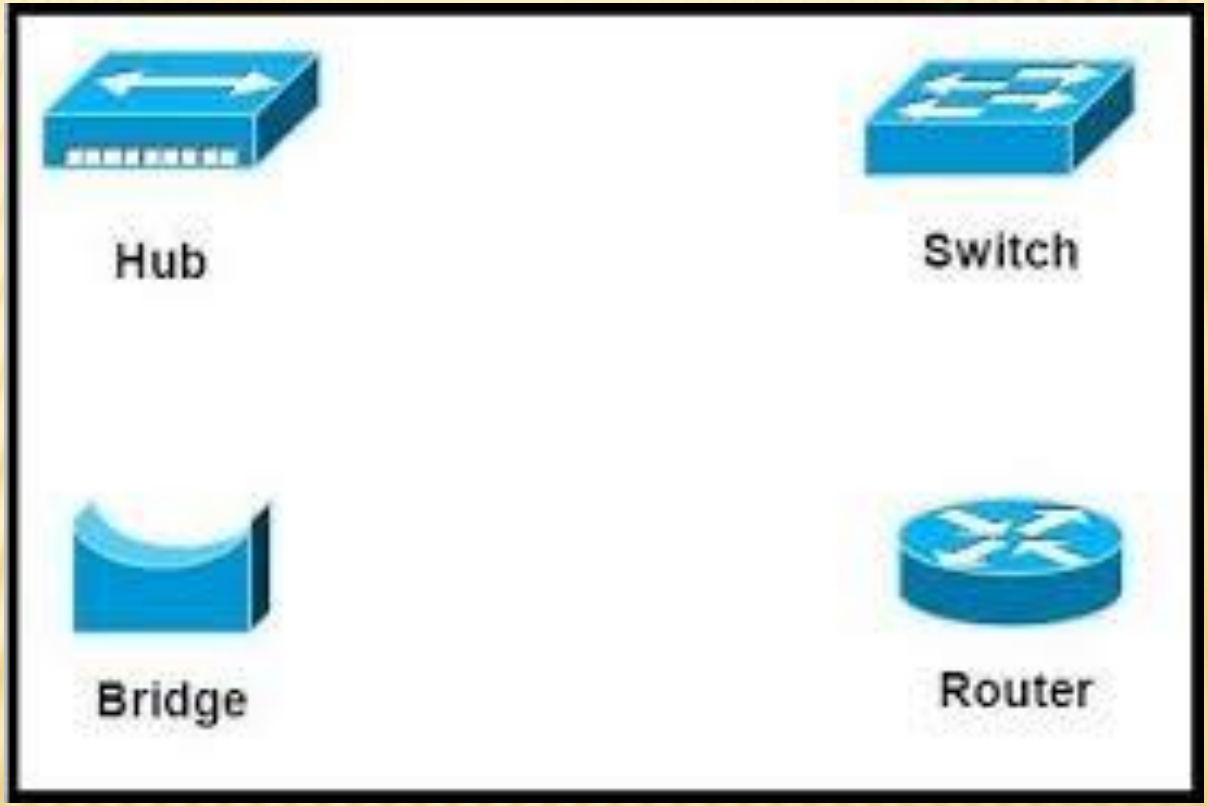
- A gateway, as the name suggests, is a passage to connect two networks together that may work upon different networking models.
- They basically works as the messenger agents that take data from one system, interpret it, and transfer it to another system.
- Gateways are also called protocol converters and can operate at any network layer.
- Gateways are generally more complex than switch or router.

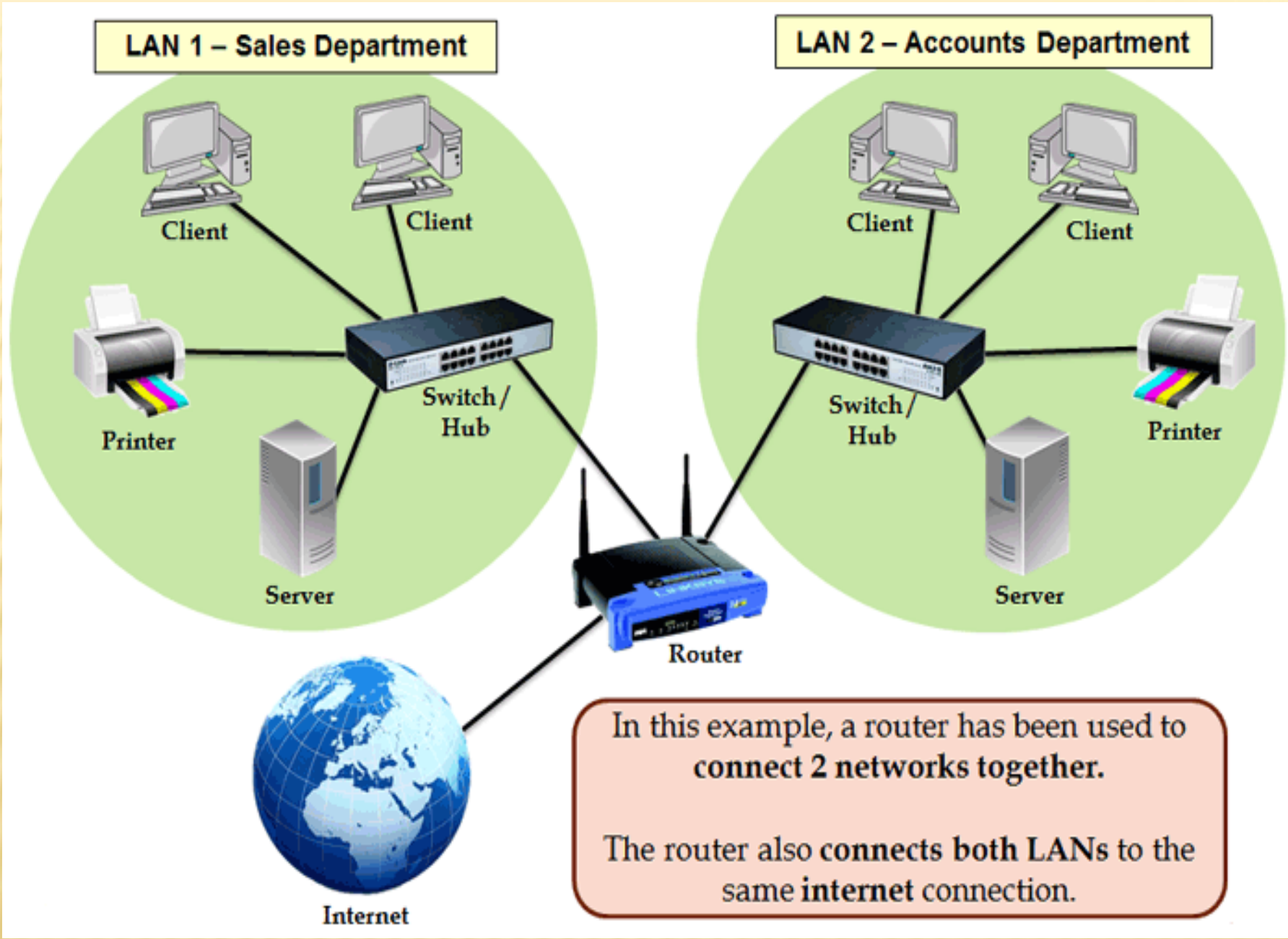

Internet
DSL/Cable modem
eth0
Gateway server
Network printer
eth1
Switch
Office Computers

BROUTER

- A brouter is a network bridge and a router combined in a single product.
- A bridge is a device that connects one local area network (LAN) to another local area network that uses the same protocol (for example, Ethernet or token ring).
- A bridge usually offers only one path to a given interconnected LAN.
- A router connects a network to one or more other networks that are usually part of a wide area network (WAN) and may offer a number of paths out to destinations on those networks.
- A router therefore needs to have more information than a bridge about the interconnected networks. It consults a routing table for this information.
- Since a given outgoing data unit or packet from a computer may be intended for an address on the local network, on an interconnected LAN, or the wide area network, it makes sense to have a single unit that examines all data units and forwards them appropriately.

SYMBOLS




LAN 1 – Sales Department
LAN 2 – Accounts Department
Client
Client
Client
Client
Printer
Switch / Hub
Switch / Hub
Printer
Server
Server
Router
Internet
In this example, a router has been used to **connect 2 networks together.**
The router also **connects both LANs** to the same **internet** connection.

END