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Data Communication CS601 Lecture No 20

Lecture Prepared By

Muhammad Abid Ali

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CS601 Lecture No 20 Topic 100 to 113

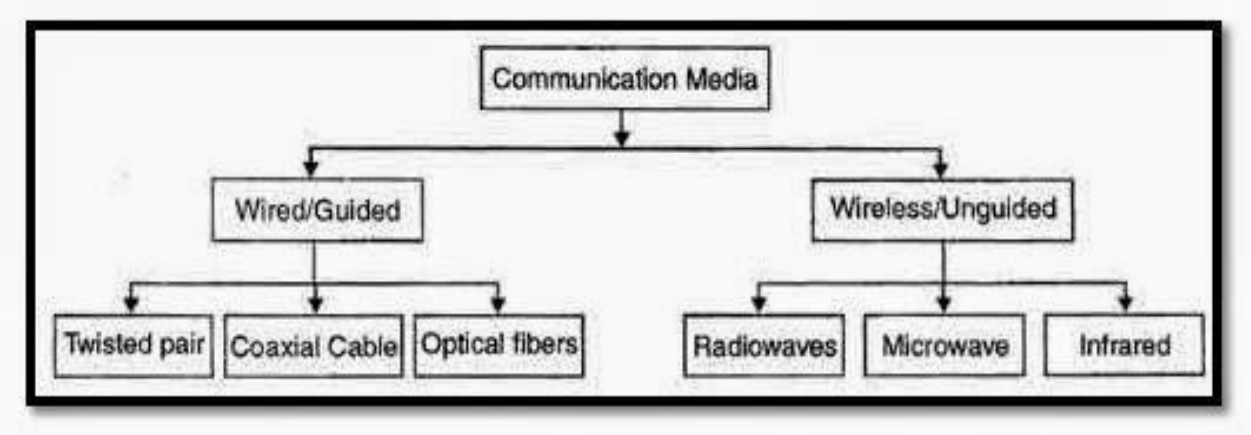
What do you mean by transmission medium?

The transmission medium can be defined as **a pathway that can transmit information from a sender to a receiver**. Transmission media are located below the physical layer and are controlled by the physical layer. Transmission media are also called communication channels.

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In transmission media is the way the systems are connected to route data signals in a network. Unguided media (wireless).

...

Differences.

Guided media	Unguided media
It is called wired communication or bounded transmission media.	It is called wireless communication or unbounded transmission media.

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BASIS FOR COMPARISON	GUIDED MEDIA	UNGUIDED MEDIA
Basic	The signal requires a physical path for transmission.	The signal is broadcasted through air or sometimes water.
Alternative name	It is called wired communication or bounded transmission media.	It is called wireless communication or unbounded transmission media.
Direction	It provides direction to signal for travelling.	It does not provide any direction.
Types	Twisted pair cable, coaxial cable and fibre optic cable.	Radio wave, microwave and infrared.

Definition of Guided Media

Guided transmission media are more commonly known as the **wired communication** or **bounded transmission media.** The electromagnetic signals travel between the communicating devices through a physical medium/conductor. As the medium

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for transmission is a physical conductor, it also provides **direction** to the signal. But there are physical limitations of the conductor in the guided media. Like the length of the conductor, its installation cost, its maintenance, etc.

The guided media is categorized further into three categories that are **twisted-pair cable, coaxial cable** and **fiber-optic cable**. The twisted pair cable has two conductors' wires wounded around each other and each surrounded by an insulating material. The twisted pair cable is flexible and easy to install. But it has *low bandwidth* and provide *less protection* from *interference*. Twisted pair cable is also of two types **shielded and unshielded twisted pair cable**.

The **coaxial cable** has a central core conductor (usually copper) enclosed in an insulating sheath, which is further encased in an outer metallic braid, it serves as both protection against noise and as a second conductor which completes the circuit. Now, the outer metallic covering is also covered by an insulating sheath. The coaxial cable carries signals of *higher frequency* than the twisted pair cable.

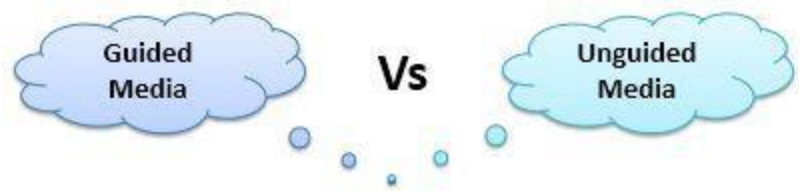
The third category is the **optical fiber** which is made of glass or plastic, and it transmits signals in the form of light. The optical fiber is *noise resistance, has less signal attenuation and has a higher bandwidth* in comparison to twisted pair cable and coaxial cable. But it also has some drawbacks like; it is *very expensive; i*t requires a lot of *installation and maintenance charge* as any defect in the cable can diffuse light and alter the signals. As the optical fiber is made of glass, it is very *fragile*.

Difference Between Guided and Unguided Media

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The computer and other communicating devices represent data in the form of signals. The signals transmit between communicating devices in the form of electromagnetic energy, and hence the signals are called **electromagnetic signals**. Electromagnetic signals are the combination of electric and magnetic fields that vibrates in relation to each other. The electromagnetic signals can travel through various transmission media. The transmission media is broadly classified into two categories that are **guided** and **unguided media**.

The basic difference between guided and unguided media is that in the **guided media**, the signal travels through a physical medium whereas, in **unguided media,** the signal travel through the air. There are some more differences between guided and unguided media which I have discussed with the help of comparison chart shown below.

Content: Guided Vs Unguided Media

1. Comparison Chart
2. Definition
3. Key Differences
4. Conclusion

Comparison Chart

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Definition of Guided Media

Guided transmission media are more commonly known as the **wired communication** or **bounded transmission media.** The electromagnetic signals travel between the communicating devices through a physical medium/conductor. As the medium for transmission is a physical conductor, it also provides **direction** to the signal. But there are physical limitations of the conductor in the guided media. Like the length of the conductor, its installation cost, its maintenance, etc.

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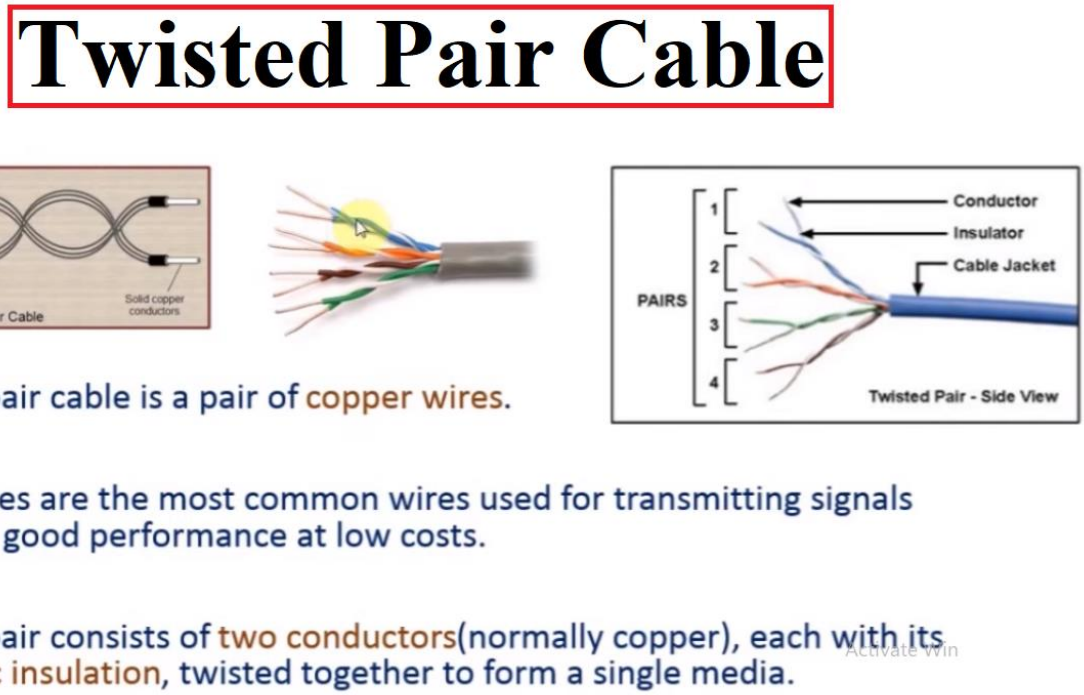
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Twisted Pair Cable

The twisted pair cable has two conductors' wires wounded around each other and each surrounded by an insulating material. The twisted pair cable is flexible and easy to install. But it has low bandwidth and provide less protection from interference. Twisted pair cable is also of two types **shielded and unshielded twisted pair cable**.

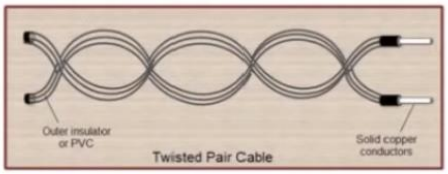


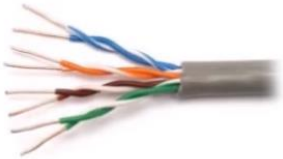
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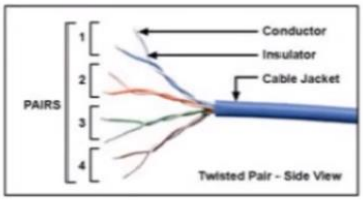
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Twisted Pair Cable







- Out of these two wires, only one carries actual signal and another is used for ground reference.
- To identify every cable, these cables are colour coated.
- The twists between wires are helpful in reducing noise (electro-magnetic interference) and crosstalk.
- This type of cable is used in telephone lines to provide voice and data channels.

There Are Two Main Types of Twisted Pair Cables

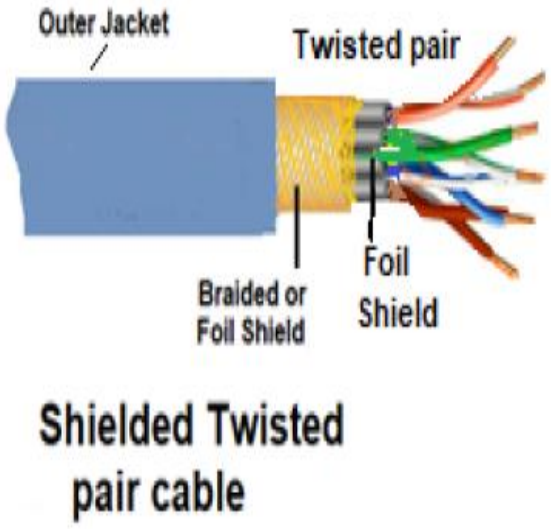
Unshielded Twisted Pair (UTP)

Shielded Twisted Pair (STP)

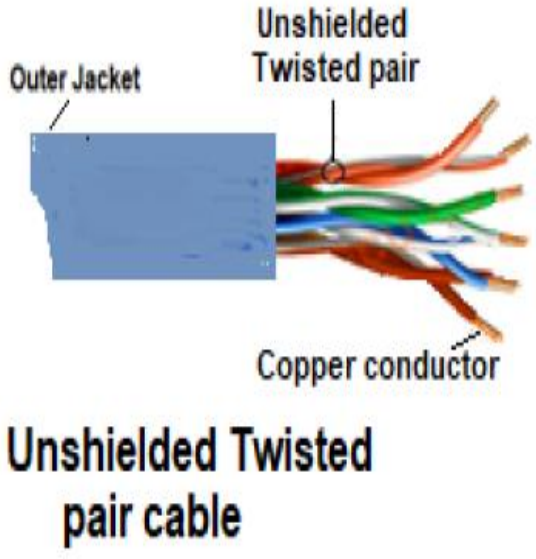
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Shielded Twisted pair cable



Unshielded Twisted pair cable

What is the difference between UTP and STP When would you use STP?

Both UTP and STP are widely used in transmitting information across distance. UTP is a cable with wires that are twisted together to reduce noise generated by an external source. On the other hand, STP is a twisted pair cable with an additional mesh shield that guards the cable against electromagnetic interference.

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Distinguish between STP and UTP:

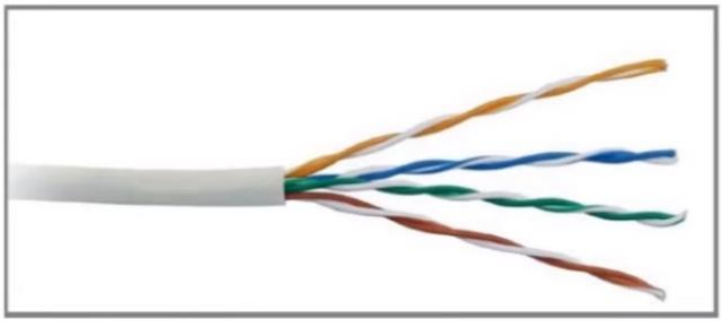
Shielded Twisted Pair	Un-shielded Twisted Pair
1. STP has a metal foil covering.	1. UTP does not have a metal foil Covering.
2. STP gives better resistance to electromagnetic interference as compared to UTP.	2. UTP does not provide better resistance to electromagnetic interference as compared to STP.
3. STP is little expensive then UTP.	3. UTP is less expensive than STP.
4. Grounding is possible.	4. Grounding is not possible.
5. Possibility of crosstalk is less as it resist to EMI.	5. Possibility of crosstalk is more as it provide less resistance to EMI.
6. Distance travelled is large and can be used in MAN.	6. Distance travelled is less and used in LAN.

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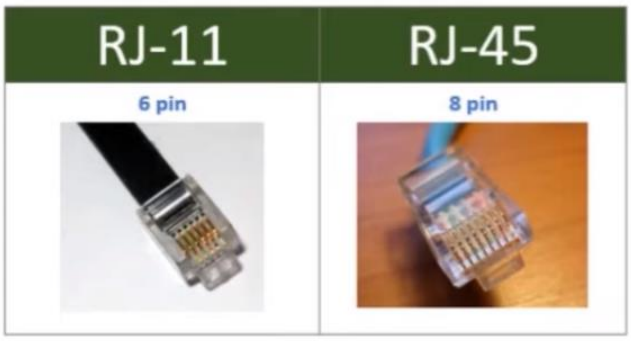


- **Unshielded twisted pair (UTP):-**
  - UTP is more common.
  - UTP cost less than STP and easily available due to its many use.
  - Due to its low cost, UTP cabling is used extensively for local-area networks (LANs) and telephone connections.
  - UTP cables consist of 2 or 4 pairs of twisted cable.
  - Cable with 2 pair use RJ-11 connector and 4 pair cable use RJ-45 connector.

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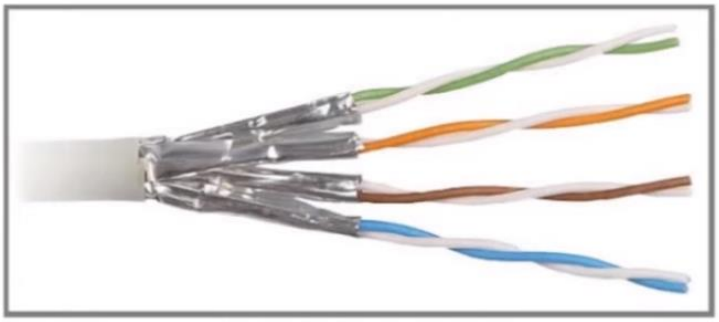


- RJ-45 connectors is used with Ethernet cables in computer networking.
- RJ-11 connectors is used in connecting telephone units.

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- **Shielded twisted pair (STP):-**
  - This type of cable has a metal foil covering which encases each pair of insulator conductors.
  - Electromagnetic noise penetration is prevented by metal casing. Shielding also eliminates crosstalk.
  - It is similar to UTP but has a mesh shielding that's protects it from EMI which allows for higher transmission rate.
  - It is more expensive than coaxial and unshielded twisted pair.

Coaxial Cable

The **coaxial cable** has a central core conductor (usually copper) enclosed in an insulating sheath, which is further encased in an outer metallic braid, it serves as both protection against noise and as a second conductor which completes the circuit. Now, the outer metallic covering is also covered by an insulating sheath. The coaxial cable carries signals of *higher frequency* than the twisted pair cable.

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Coaxial Cable



- **Coaxial cables** are copper cables with better shielding than twisted pair cables, so that transmitted signals may travel longer distances at higher speeds.
- The shield minimizes electrical and radio frequency interference.
- Coaxial cabling is the primary type of cabling used by the cable television industry and is also widely used for computer networks such as Ethernet.

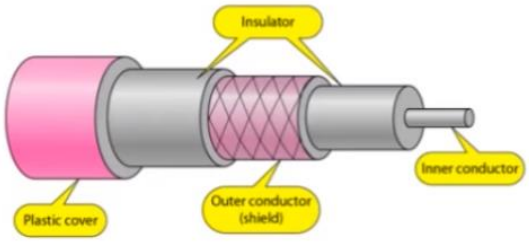
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Coaxial Cable





- Coaxial cable has two wires of copper.
- The core/inner copper wire in centre and is made of solid conductor. It is enclosed in an insulating sheath.
- The second/outer copper wire is wrapped around, and is used to protect from external electromagnetic interference(Noise).
- This all is covered by plastic cover used to protect the inner layers from physical damage such as fire or water.

Coaxial Cable Standards

- Coaxial cables are categorized by their Radio Government (RG) ratings. Each RG number denotes a unique set of physical specifications
  - 50-Ohm RG-7 or RG-11 : used with thick Ethernet.
  - 50-Ohm RG-58 : used with thin Ethernet
  - 75-Ohm RG-59 : used with cable television

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Optical Fiber

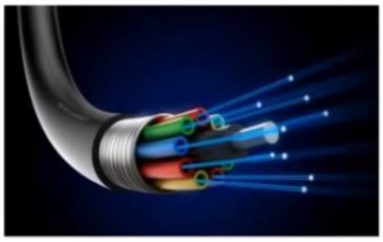
The third category is the **optical fiber** which is made of glass or plastic, and it transmits signals in the form of light. The optical fiber is *noise resistance, has less signal attenuation and has a higher bandwidth* in comparison to twisted pair cable and coaxial cable. But it also has some drawbacks like; it is very expensive; it requires a lot of installation and maintenance charge as any defect in the cable can diffuse light and alter the signals. As the optical fiber is made of glass, it is very fragile.

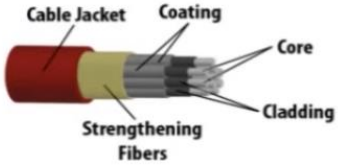
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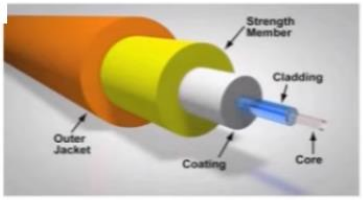
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Optical Fiber







- A fibre optic cable is made of high quality of thin glass or plastic and is used to transfer digital data signals in the form of light up to distance of thousand of miles.
- Fibre optic cables are not affected by electromagnetic interference, so noise and distortion is very less.
- Fibre optic cables carry communication signals using pulses of light generated by small lasers or light-emitting diodes (LEDs).
- The cable consists of one or more strands of glass, each only slightly thicker than a human hair. The centre of each strand is called the core, which provides the pathway for light to travel. The core is surrounded by a layer of glass called cladding that reflects light inward to avoid loss of signal and allow the light to pass through bends in the cable. No light escapes the glass core because of this reflective **cladding.**

- **Advantages of Optical Fibre:-**
  - **Fibre optic cables have a much High bandwidth than metal cables. This means that they can carry more data.**
  - **Smaller Size and Lighter weight.**
  - **low attenuation**
  - **Not affected electromagnetic interference (No EMI interference)**
  - **Signals carrying data can travel long distances without weakening**
  - **Suitable for industrial and noisy areas**

- **Disadvantages of Optical Fibre:-**
  - **Optical fibre cables are expensive**
  - **Difficult to install**
  - **Maintenance is expensive and difficult**

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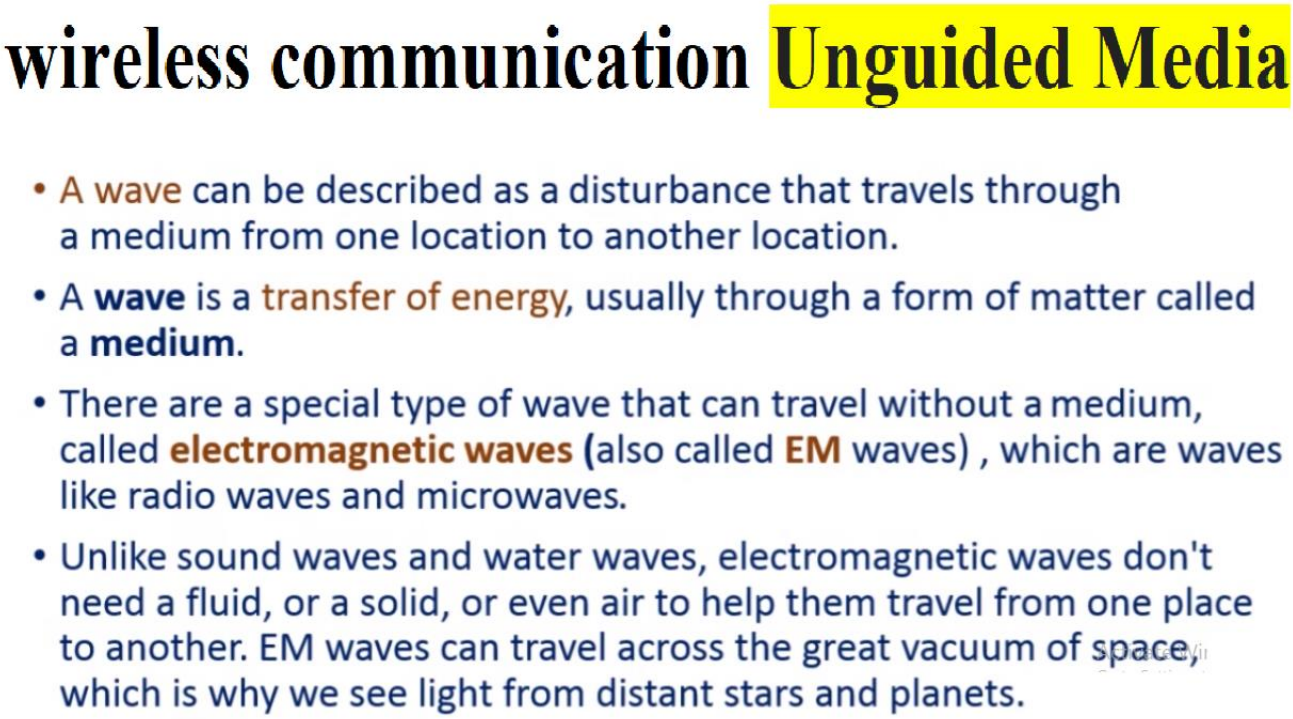
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Definition of Unguided Media

The **unguided media** is also called **wireless communication**. It does not require any physical medium to transmit electromagnetic signals. In unguided media, the electromagnetic signals are broadcasted through air to everyone. These signals are available to one who has the device capable of receiving those signals.

The unguided media is also called unbounded media as it does not have any border limitation. The unguided media allows the user to connect all the time, as the communication is wireless the user can connect himself from anywhere to the network.

The unguided media is categorized into **radio waves, microwaves and infrared waves**.



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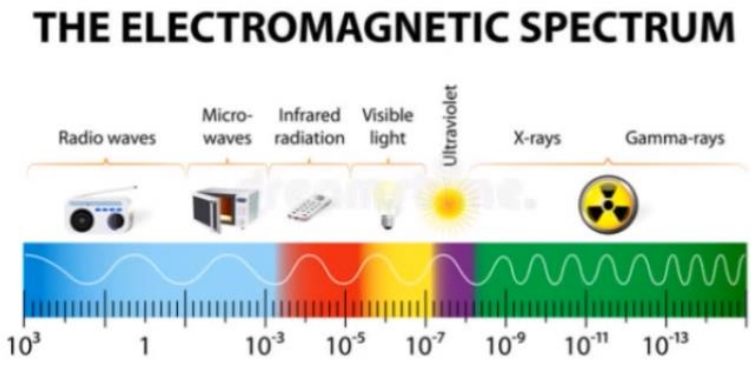
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wireless communication Unguided Media

- Electromagnetic waves are formed when an electric field comes in contact with a magnetic field. They are hence known as 'electromagnetic' waves.
- Electromagnetic (EM) radiation is a form of energy that is all around us and takes many forms, such as radio waves, microwaves, X-rays and gamma rays.
- Sunlight is also a form of EM energy. Electromagnetic energy from the sun comes to Earth in the form of radiation.
- The Electromagnetic Spectrum describes a wide range of different **electromagnetic waves**.

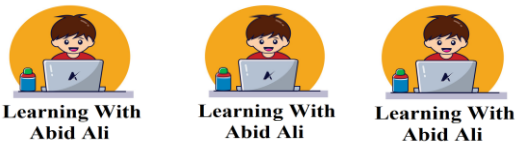
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- A little part of electromagnetic spectrum can be used for wireless transmission.

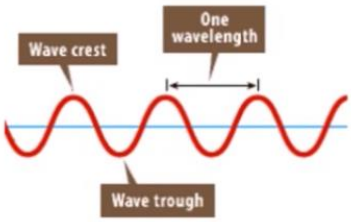


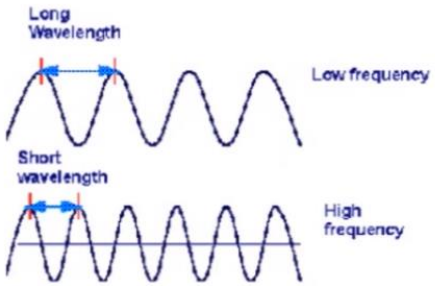
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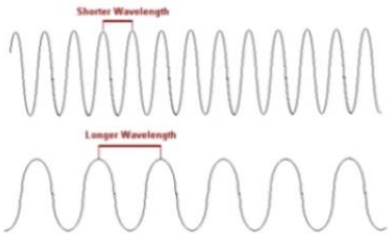
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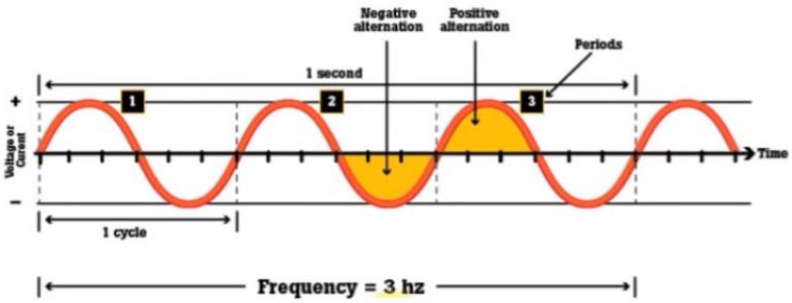


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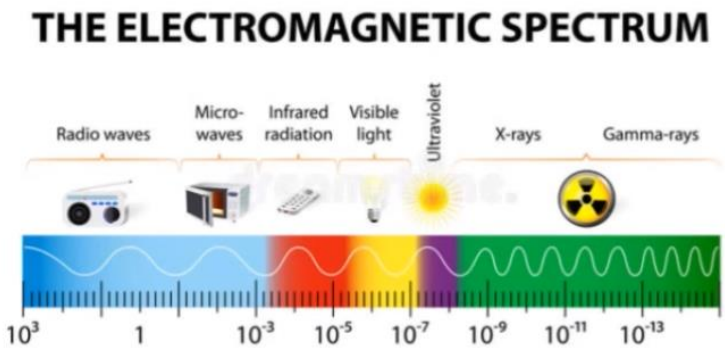


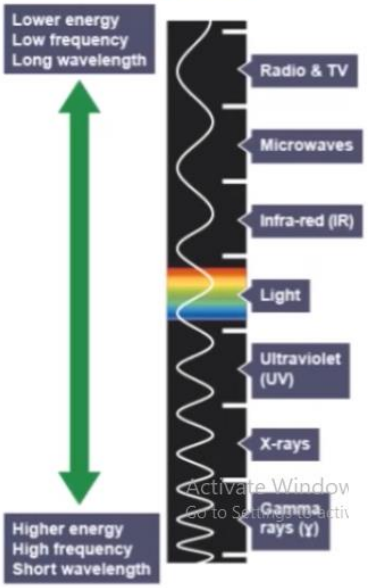






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Radio Waves

The **radio waves** are generated easily; they are *low-frequency signals* and can travel a *long distance*. The radio waves can penetrate through the buildings.

Radio Waves

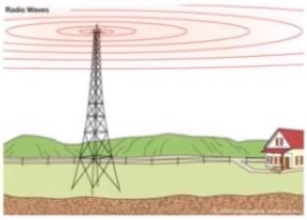


- Radio waves are EM (Electromagnetic)waves that have wavelengths between 1 millimetre and 100 kilometres (or 300 GHz and 3 kHz in frequency).
- Radio frequency is easy to generate because its has large wavelength and can travel long distance.
- Radio waves are generated by radio transmitters and received by radio receivers.
- Radio stations transmit radio waves using transmitters, which are received by the receiver installed in our devices. Both transmitters and receivers use antennas to radiate or capture radio signals
- It can penetrate walls easily, so these waves are widely used for communication both indoors and outdoors.

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Radio Waves



- Radio waves are omnidirectional means they travel in all the directions from the source.
- When an antenna transmits radio waves, they are propagated in all directions.
- A sending antenna send waves that can be received by any receiving antenna. The omnidirectional property has disadvantage, too. The radio waves transmitted by one antenna are susceptible to interference by another antenna that may send signal using the same frequency or band.
- It is Used Mobile, AM/FM radio, television

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Radio Waves



- Radio waves are EM (Electromagnetic)waves that have wavelengths between 1 millimetre and 100 kilometres (or 300 GHz and 3 kHz in frequency).
- Radio frequency is easy to generate because its has large wavelength and can travel long distance.
- Radio waves are generated by radio transmitters and received by radio receivers.
- Radio stations transmit radio waves using transmitters, which are received by the receiver installed in our devices. Both transmitters and receivers use antennas to radiate or capture radio signals
- It can penetrate walls easily, so these waves are widely used for communication both indoors and outdoors.

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Radio Spectrum

Radio Band	Frequency	Some Applications
Very Low Frequency VLF	3 KHZ to 30 KHz	Radio Navigation
Low Frequency LF	30 KHz to 300 KHz	Long Wave Radio
Medium Frequency MF	30 KHz to 3 MHz	AM Radio
High Frequency HF	3 MHz to 30 MHz	CB Radio (HAM) Point to Point Radio Search and Rescue Services
Very High Frequency VHF	30 MHz to 300 MHz	FM radio 88-108 MHz VHF Broadcast TV
Ultra High Frequency UHF	300 MHz to 3 GHz	UHF Broadcast TV Cellular Phones Microwave Links Wi-Fi in 2.4 Band Satellite Communications
Super High Frequency SHF	3 GHz to 30 GHz	Microwave Links Wi-Fi in 5 GHz Band Satellite Communications
Extra High Frequency EHF	30 GHz to 300 GHz	Microwave Links

Microwaves

The **microwaves** are transmitted in a straight line and hence require the **line-of-sight transmission**. The distance covered by the microwave signal depend on the height of the two antennas. More the taller are antennas longer is the distance covered by the signal. The microwave has a *frequency higher* than the radio waves. Microwave are used for telephone communication mobile phones, television distribution, etc.

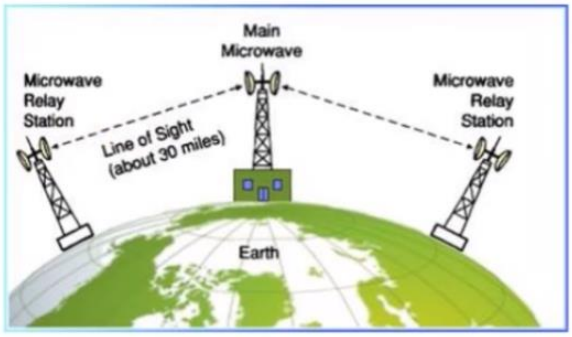
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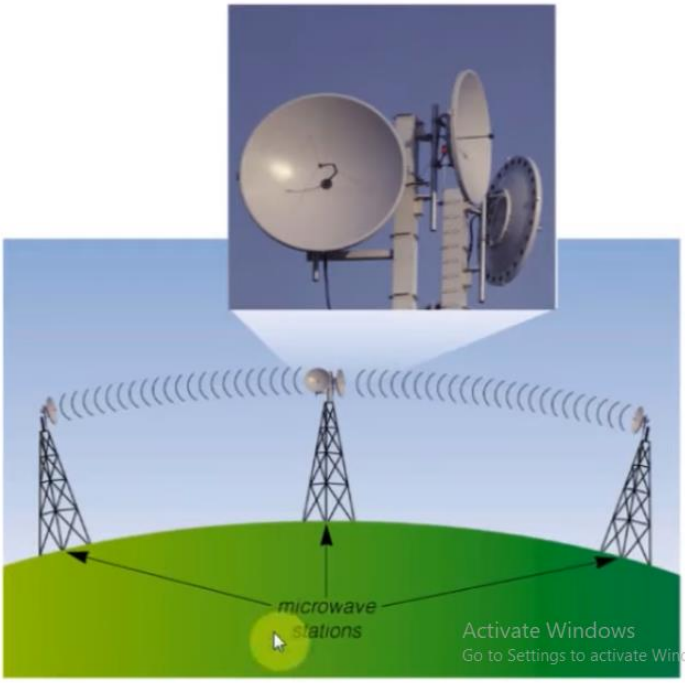
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Microwaves

- Microwaves are a type of radio waves with high frequencies. It can be classified as a subclass of radio waves. The frequency of microwaves lies in the 300 MHz to 300 GHz.
- Unlike radio waves, microwaves are unidirectional, in which the sending and receiving antennas need to be aligned.
- Microwaves are widely used for point-to-point communications because their small wavelength, which means that the signal is focused into a narrow beam. Additionally, each antenna must be within line of sight of the next antenna.
- Electromagnetic waves above 100 MHz tend to travel in a straight line and signals over them can be sent by beaming those waves towards one particular station. Because Microwaves travels in straight lines, both sender and receiver must be aligned to be strictly in line-of-sight.





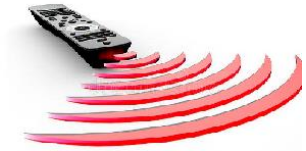
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Infrared waves are used for short range communication. Like, the remote control for televisions, VCRs, etc. uses infrared waves. It can not penetrate through obstacles. The government license is not required, to operate an infrared system as it is more secure against eavesdropping.

Infrared waves



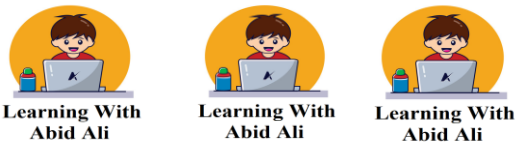
- **Infrared signals have frequencies between 300 GHz to 400 THz. They are used for short-range communication.**
- **Infrared waves are used for very short distance communication like TV remote, wireless speakers, automatic doors, hand held devices etc.**
- **Infrared waves having high frequencies prevents interference b/w one system to another.**
- **Infrared signals have high frequencies and cannot penetrate walls. Due to its short-range communication system, the use of an infrared communication system in one room will not be affected by the use of another system in the next room. This is why using an infrared TV remote control in our home will not interfere with the use of our neighbour's infrared TV remote control.**
- ***THE DISADVANTAGES OF USING INFRARED***
  - **Infrared signals cannot be used for long distance communication. In addition, we cannot use infrared waves outside a building because sun's rays contain infrared waves that can interfere with communication.**

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Key Differences Between Guided and Unguided Media

1. The key difference between guided and unguided media is that guided media uses a **physical path or conductor** to transmit the signals whereas, the unguided media **broadcast the signal** through the air.
2. The guided media is also called **wired communication** or **bounded transmission media**. However, the unguided media is also called **wireless communication** or **unbounded transmission media**.
3. The guided media provide **direction** to the signal whereas, the unguided media **does not direct** the signal.
4. Categories of guided media are **twisted pair cable, coaxial cable** and **optical fibre**. On the other hands, the categories of unguided media are **radio wave, microwave,** and **infrared signal**.