Transmission Media

- Electromagnetic Spectrum for Telecommunication
- Type of Propagation
- Guided Transmission Media: Twisted Pair Cable, Coaxial Cable, Optical Fiber, Characteristics of Unguided Communication Bands, Antennas
- Unguided Transmission Media: Terrestrial Microwave, Satellite Communication, VSAT, and Cellular Telephony

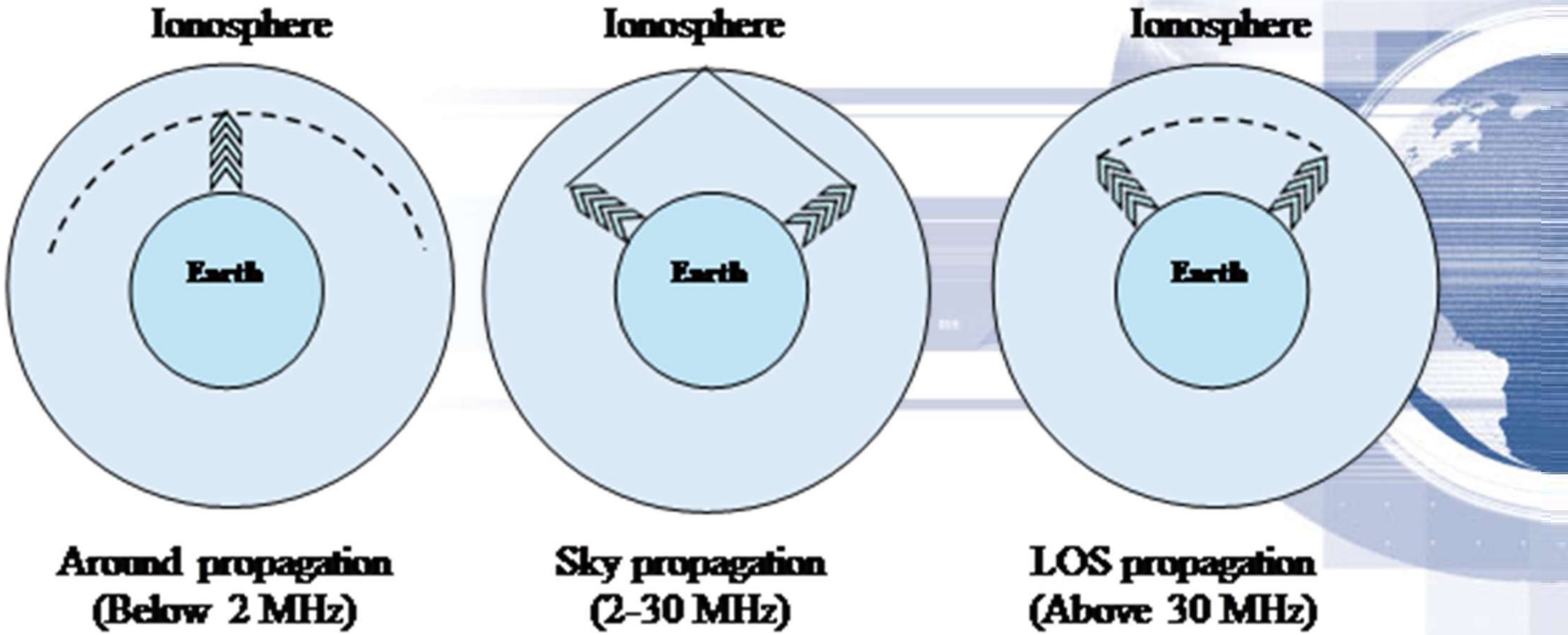
Electromagnetic Spectrum for Telecommunication

Electromagnetic Waves

The EM waves used propagation characteristics of wireless channels are highly depend on frequency. Here, interference and propagation condition are strongly dependent on frequency.

Electromagnetic Spectrum for Telecommunication

Types of EM Waves



Electromagnetic Spectrum for Telecommunication

Types of Propagation

1. Ground Wave Propagation

- In this propagation, EM waves are guided by the conducting surface at the earth, along which they are propagated.
- It's prominent mode of propagation for frequency below 2 MHz.

Electromagnetic Spectrum for Telecommunication

1. Ground Wave Propagation

- The diffraction of the wave causes it to propagate where there this propagation made is used in AM broadcasting.
- For efficient radiation, the antenna needs to be longer than $\frac{1}{10}^{th}$ of the wavelength.

2. Sky Propagation

- Dominant mode of propagation for frequencies in between 2 to 30 Mhz.
- Long distance coverage is obtained by the reflecting the wave at the ionosphere and at the earth boundaries.
- This is caused due reflection.

Electromagnetic Spectrum for Telecommunication

3. Line of Sight (LOS) Propagation

- Dominant mode of propagation for frequencies above 30 MHz
- Very little reflection by the ionosphere.
- This is used for satellite communication.

Guided Transmission Media

The guided media are those, provides physical conduction from one device to another which includes twisted pair coaxial cable and fiber-optic.

Twisted Pair Cable

- It consists of two insulated copper wire arranged in a regular spiral pattern.
- A wire pair acts as a single communication link.

Twisted Pair Cable

- Typically, no. of these pairs is bundled together into a cable by wrapping them into a touch protective sheath.
- The twisting tends to decrease the cross talk, interference between the adjoint pairs in a cable.

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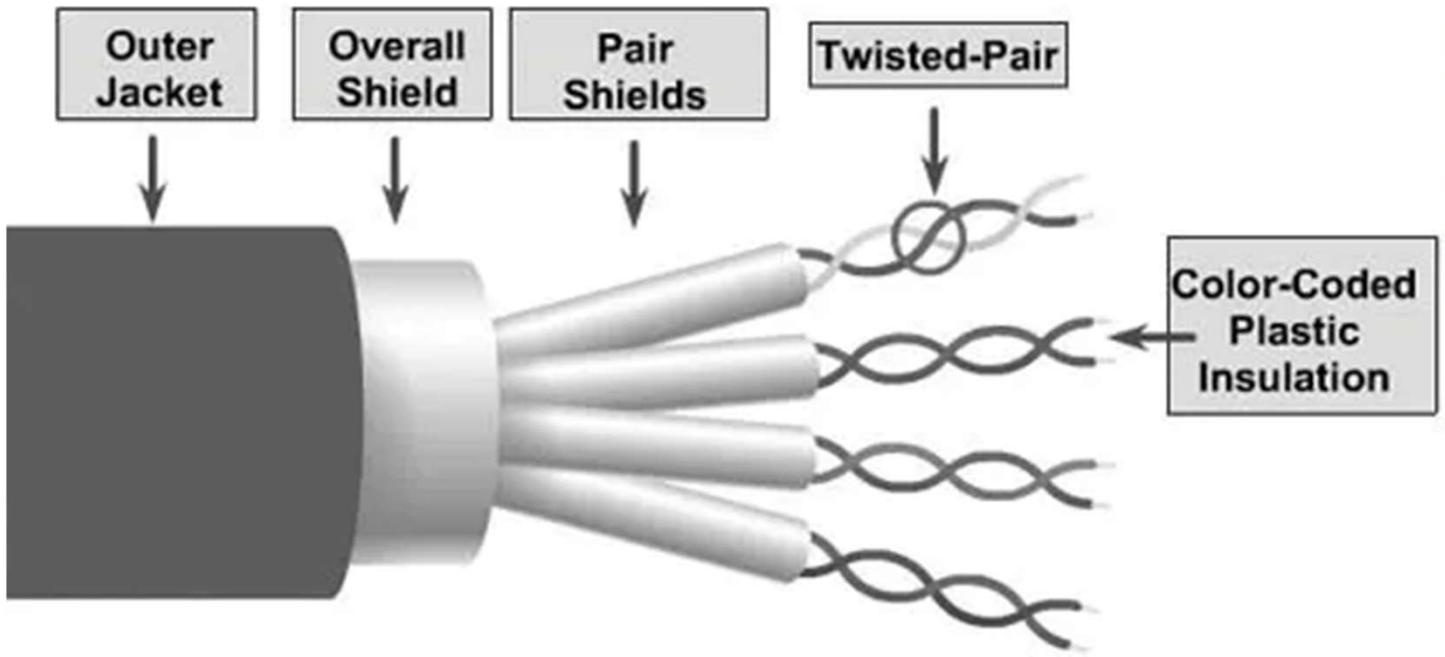
Twisted Pair Cable



Twisted Pair Cable

Types:

1. Unshielded Twisted Pair (UTP)

This is the most common type of twisted pair wiring, used primarily for telephone and computer. Despite not having a protective shielding, it relies on the twisting design to reduce noise and maintain signal quality.

Twisted Pair Cable

Types:

2. Shielded Twisted Pair (STP)

This type of cable includes a layer of insulation and an outer protective shield around each pair or around the group of pairs. STP is designed to offer more protection against interference, making it ideal for environments with potential EMI.

Twisted Pair Cable

Pros:

- They are more affordable compared to other types of cables.
- They are lightweight, flexible, and easy to install.
- They offer a good range of distance on a single cable run.

Twisted Pair Cable

Cons:

- They are more vulnerable to interference if not properly shielded.
- Their data transfer speed is lower compared to optical fiber cables.
- Signal quality can degrade over long distances.

Twisted Pair Cable

Applications:

- **Telecommunications:** Twisted pair cables are extensively used in telephone networks where signals are transmitted digitally.
- **Computer Networks:** In local area networks (LANs), twisted pair cables are used for data transmission, connecting computers, and other network devices.
- **Video Applications:** Twisted pair cables are also utilized in video surveillance systems.

Coaxial Cable

- Coaxial cable carriers signal of higher frequency ranges than those twisted pair cable.
- Instead of having two wires, coaxial cable has a central core conductor of solid or stranded wire enclosed in an insulating sheath, which is in turn enclosed in an outer conductor of metal foil.
- The outer metallic wrapping serves both as a shield against noise & as the second conductor, which completes the circuit.

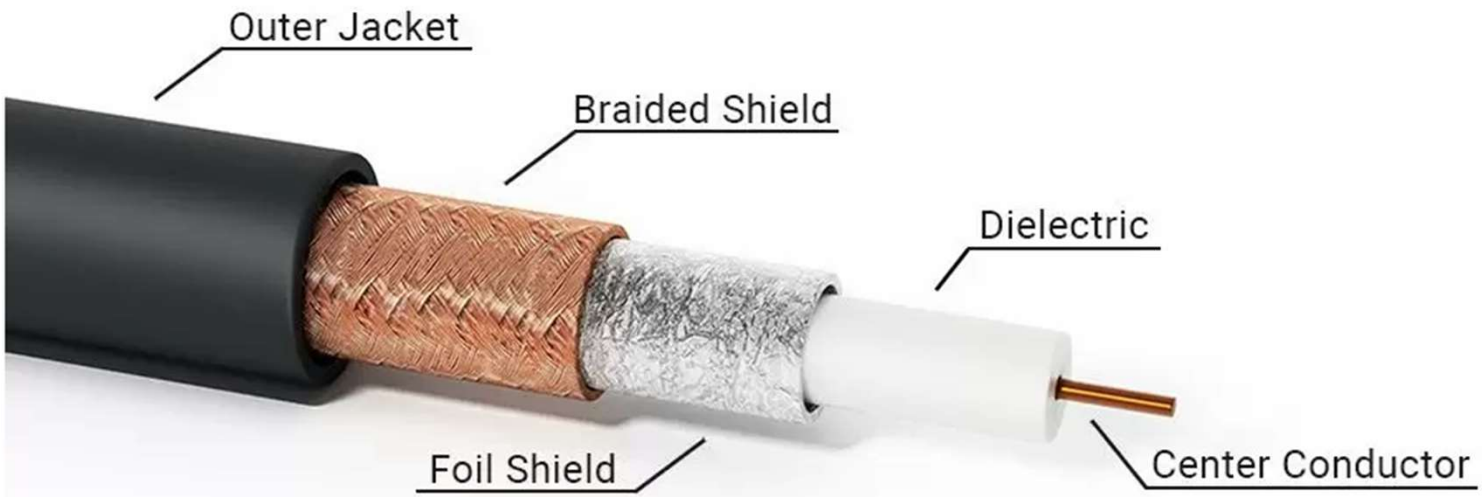
Coaxial Cable

- The outer conductor is also enclosed in an insulating sheath and the whole cable is protected by plastic cover.
- Co-axial cables are categorized as following according to their uses.

Category	Uses
RG-59	Cable TV
RG+58	Thin Ethernet
RG-11	Thick Ethernet

Coaxial Cable

- Coaxial cable has much higher bandwidth but the signal weakens rapidly and requires the frequent use of repeaters.



Coaxial Cable

Pros:

- Coaxial cable is very durable
- Best performance in short-distance transmission

Cons:

- Long-distance signal loss is serious
- Signal leakage at the connection
- Speed fluctuation under heavy use

Coaxial Cable

Applications:

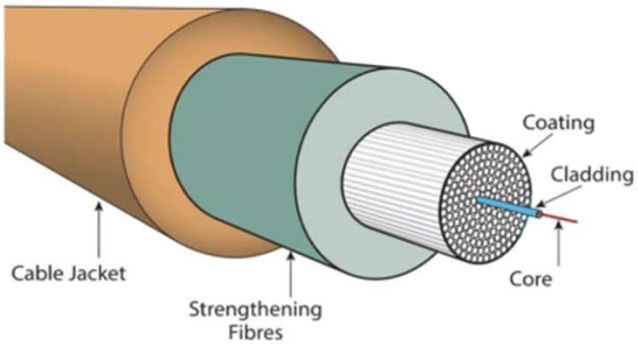
- **Internet and Networking:** Coaxial cable is also used in networking applications to connect modems and routers and offer high-speed internet access.
- **Security System:** Closed-circuit television (CCTV) and other security systems frequently employ coaxial cable.
- **Industrial Applications:** Coaxial cable is frequently utilized in industrial settings, such as for tying sensors and other equipment to control and monitor systems.

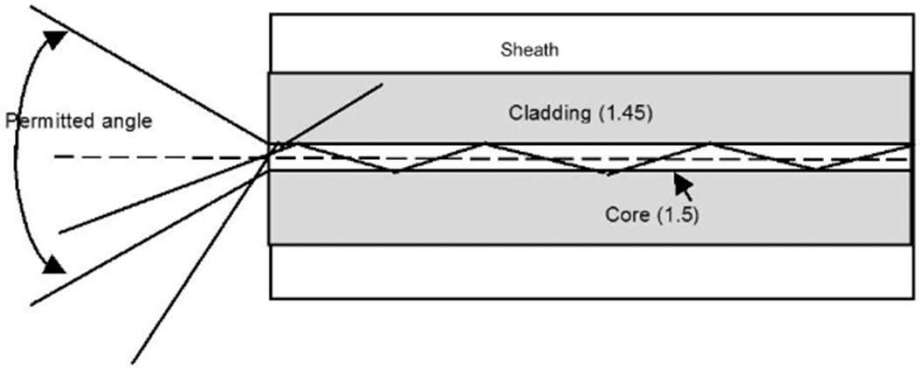
Optical Fiber

- An optical fiber cable is made up of glass or plastic and transmits signals in the form of light.
- Optical fiber use reflection to guide light through a channel. The optical fibers consist of three layers; core, cladding and coating.
- A glass or plastic core is surrounded by a cladding of less dense glass or plastic.

Optical Fiber

- The different in density of the two materials must be in such a way that the beam of light through the core is reflected off the cladding instead of being refracted into it.





Optical Fiber

Pros:

- **Greater Bandwidth:** The most notable advantage of a fiber optic cable is that it provides significantly improved performance when it comes to bandwidth.
- **Longer Distances:** Fiber optic cables are designed to carry signals over much longer distances than traditional cabling as they offer low power loss.

Optical Fiber

Pros:

- **Thin & Lightweight:** Optical fibers are much thinner and lighter than copper wires.
- **Less Interference:** As fiber optic cables are resistant to electromagnetic interference. Not only does this mean the rate of error is low.
- **High-Level Security:** Fiber don't radiate electromagnetic energy; it is extremely difficult to 'listen' in or tap. This makes it the most secure medium available for carrying sensitive data.

Optical Fiber

Pros:

- **Strong, Reliable & Flexible:** Optic fibers possess greater tensile strength, it also isn't as affected anywhere near as much by weather, moisture or corrosive elements as metal wiring can be

Optical Fiber

Cons:

- **Production & Installation Cost:** The cost to produce optic fiber cabling is higher than that of copper. Installation is also more expensive as special test equipment is usually required.
- **Fragility:** As they are made of glass, fiber optic cables are more fragile than electrical wires like copper cabling.
- **Splicing Difficulties:** When deploying a new fiber optic network or expanding an existing one, the fibers need to be properly sliced to avoid network disruptions.

Optical Fiber

Applications:

- Some cable TV companies use combination of optical fiber and coaxial cable.
- LANs such as 100 Base-FX and 1000 Base-X also use fiber optical.
- It is often found in backbone network.

Characteristics of Unguided Communication Bands

Unguided communication band refers to the frequency ranges in which EM-wave propagates through free space without any physical medium, such as cables or waves guides, guiding their path. The communication bands are commonly used for wireless communication and include radio waves, microwave and other forms of EM-radiation.

Characteristics of Unguided Communication Bands

Its characteristics are:

- Propagation through free space without physical medium.
- Inherent omnidirectional propagation.
- LOS and non-LOS communication.
- Susceptibility of environmental factor such as atmospheric condition, interface from other electrical devices.
- Cover wide range of frequencies including radio wave (KHz ro GHz), microwave (GHz to THz).
- Regulation & allocation.
- Wavelength & antenna size.

Antennas

It is the device which transmits or receives the signal from space. Antennas are always mounted on a tower so that it becomes easy to transmit signal for long distance. Depending upon the communication, antennas are of following types:

i) Isotropic Antenna: It is hypothetical antenna which radiates equally in all directions. It is not physically reliable.

Antennas

i) Omnidirectional Antenna: It can radiate signal around it in all directions so its shape is cylindrical.
ii) Directional Antenna: It radiates or receives the signal in a particular direction.

Unguided Transmission Media

Unguided media transport electromagnetic eaves without using a physical conductor. This type of communication is often referred to as wireless communication. Signals are usually broadcast through free space & thus are available to anyone who has a device capable of receiving them.

Terrestrial Microwave

- The EM-waves ranging in frequencies between 1 and 300 GHz are known as microwaves.

Microwaves are unidirectional when an antenna transmits microwaves, they can be narrowly focused. This means that sending & receiving antenna need to be aligned.

Terrestrial Microwave

- In this system, a transmitter sends out electrical signals representing the data to be transmitted. A receiver accepts the signal and converts them into digital form, which can be fed into the computer.
- At microwave frequencies the EM waves cannot bend or pass obstacles like hills, buildings. Hence, it is necessary that microwave transmission is in a line of sight.
- In other words, the transmitter & receiver of a microwave system, which are mounted on very high towers, should be in a LOS.

Terrestrial Microwave

- Moreover, the signals become weaker after travelling a certain distance & require power amplification.
- To overcome the problem of LOS & power amplification of weak signals, microwave systems use repeaters at intervals of about 30 to 40 Km in between the transmitting & receiving stations.

Terrestrial Microwave

Applications:

i) They are useful when unicast (one-to-one) communication is needed between sender and receiver.

ii) They are used in cellular phones, satellite networks and wireless LANs.

Satellite Communication

- A satellite communication is an artificial satellite station in space for the purpose of telecommunications using at microwave frequencies.
- A communication satellite is basically a microwave relay station place in or out of spaces.
- A satellite receives radio signal in each frequency band, change their frequency and retransmits them.

Satellite Communication

- The message signal is transmitted from the earth station through an up-link to the satellite. It is amplified translated to the downlink frequency in a transponder present in the satellite and sent back to another earth station.
- Satellite uses one frequency for transmission and other for receiving to avoid interference.
- The frequency transmitted from the ground station to the satellite is known as up link (6 GHz and 14 GHz)
- The frequency at which the satellite retransmits amplified signals to the ground is known as down link (4 GHz to 12 GHz)

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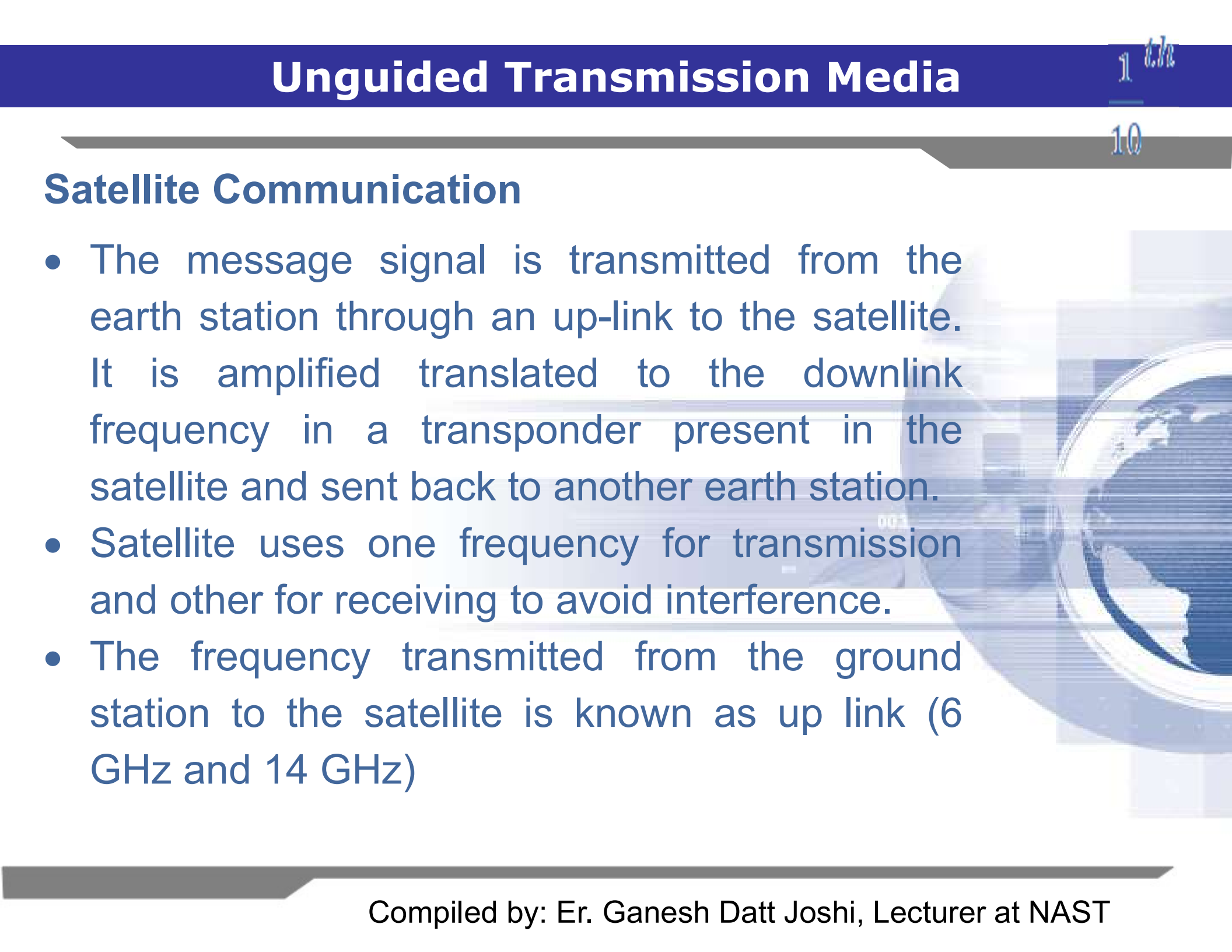

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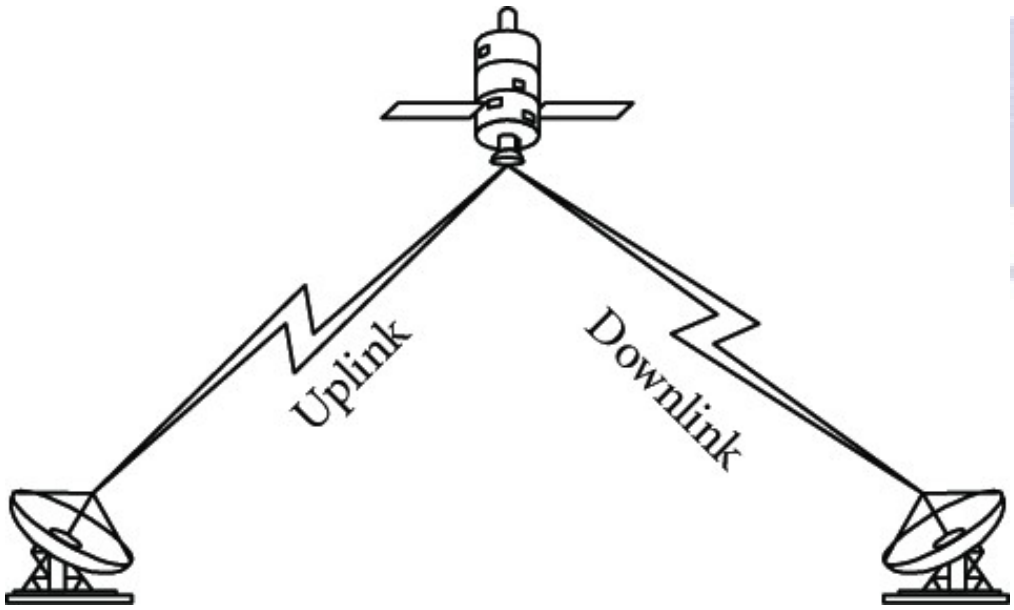
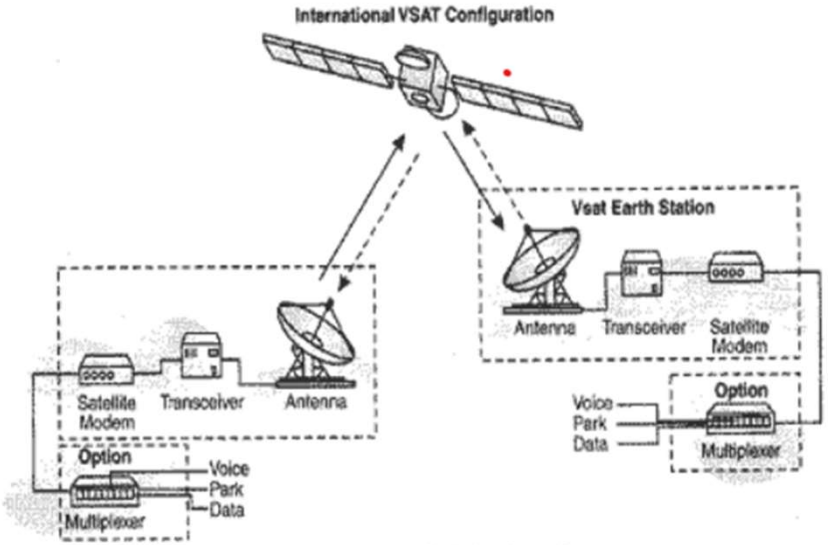


Very Small Aperture Terminal (VSAT)

- The satellite provider can divide the total capacity into several channels and leave these channels to individual user. A user equipped with antennas at the no. of sites can use a satellite channel for a private network.
- VSAT system provide the facility of division of total capacity of single satellite to multiple private users. It is low cost and consists of small terminals. It provides direct communication between a central point and the large number of remote points or both remote terminal via a central hub.

Very Small Aperture Terminal (VSAT)

- VSAT are fixed terminal, so they are considered to fixed satellite service. The central hub can communicate with the small terminal. In this way, communication can possible in remote areas.



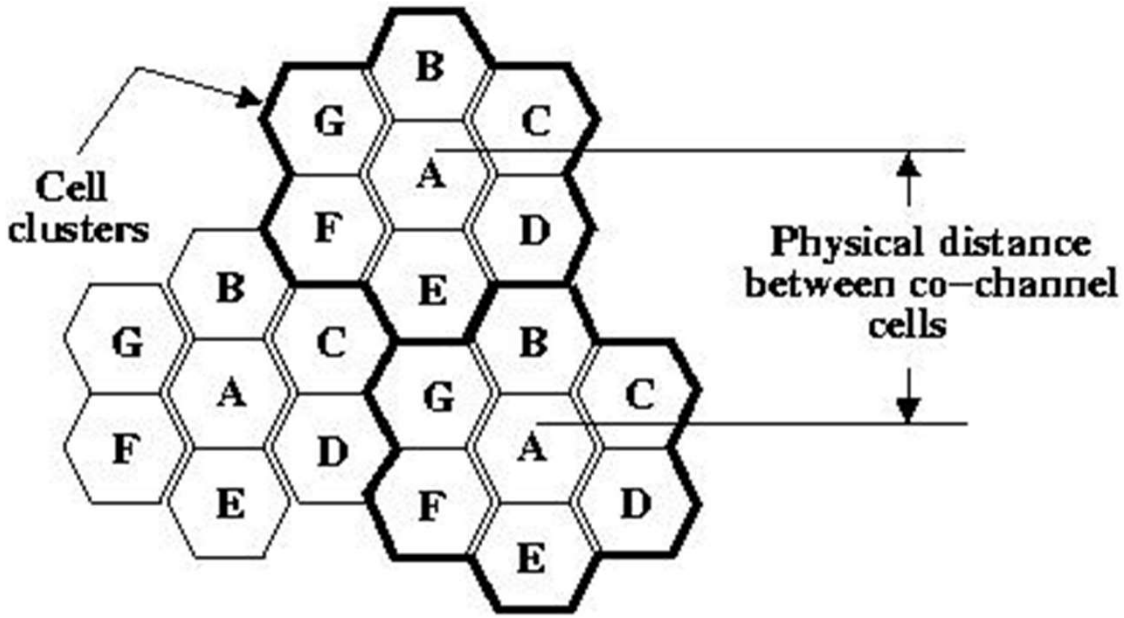
A Typical VSAT Configuration.

Cellular Telephony

- In cellular telephony system, each cell has Base Transceiver Station (BTS) i.e. antenna. The BTS can transmit and receive the signal so called as transceiver.
- A cell is small geographical region having range 1-5 Km. The main purpose of cellular network is for communication between two moving users. This is known as mobile communication system.

Cellular Telephony

- The architecture of cellular network is shown in figure below, where A, B, C, D, E, F and G are hexagonal shape.



Cellular Telephony

- Generally, cellular network is 7 cell or 4 cell structure and this structure is known as cluster.
- Each cell can cover large population, depending on population the cell size can be designed foe good signal coverage.
- In city area cell size is small but in village or rural area, its size is large.

Cellular Telephony

- All cell has different frequency in one 7 cell structure, this is for no occurrence of interference, crosstalk.
- These frequencies are used such that there is no overlapping or nearby to the other frequency. This technique is known as frequency reuse.
- Cellular telephony can be defined a communication is a certain geographical region and region to region namely cell.