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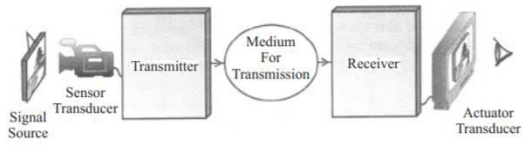
COMMUNICATION SYSTEMS

A MODEL COMMUNICATION SYSTEM

- Communication systems endeavour to transmit information from –
- one to one, i.e., point-to-point communication; – one to many, i.e., broadcast communication;
- – many to many, i.e., telephone conference call or a chat room.



Elements of a Communication System

- a source of signal, a sensor transducer and a transmitter, which launches the signal carrying information.
- an intervening medium/channel to guide and carry the signal over long distances, and
- a signal receiver and an actuator transducer to intercept the signal and retrieve the information.

TYPES OF SIGNALS – ANALOGUE AND DIGITAL

continuous time (analog) and discrete time (digital) signals;

– coded and uncoded signals; –

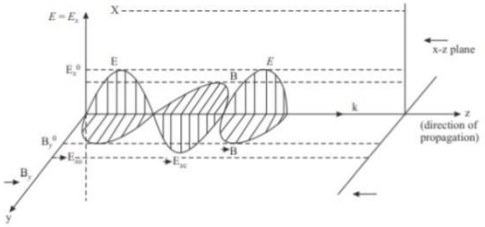
periodic and aperiodic signals;

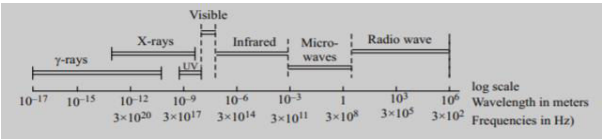
– energy and power signals; and – deterministic and random signal.

BAND WIDTH OF SIGNALS

- The most crucial parameter in communication systems is the signal bandwidth, which refers to the frequency range in which the signal varies. However, it has different meaning in analog and digital signals.
- While analog bandwidth measures the range of spectrum each signal occupies, digital bandwidth gives the quantity of information contained in a digital signal.

Electromagnetic Waves in Communication





COMMUNICATION MEDIA

- There are two types of communication channels:
- wireline (using guided media) or

- wireless (using unguided media). Wireline channels physically connect the transmitter to the receiver with a "wire," which could be a twisted pair of transmission lines, a coaxial cable or an optical fibre. Consequently, wireline channels are more private and comparatively less prone to interference than wireless channels

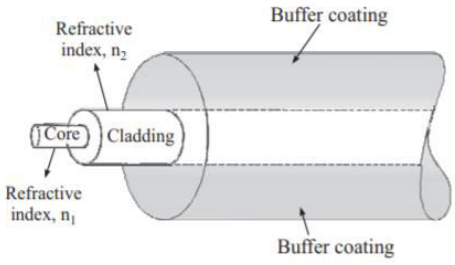
Transmission lines

Optical Fibre

The 1960 invention of the laser (acronym for Light Amplification by Stimulated Emission of Radiation) completely revolutionized communication technology.

The laser, which is a highly coherent source of light waves, can be used as an enormously high capacity carrier wave for information carrying signals (voice, data or video) transmitted through an optical waveguide, such as an optical fibre.

The basic principle involved in all long distance communication systems is **multiplexing**, i.e., simultaneous transmission of different messages over the same pathways.



Five layers are considered to play main role in communicaiton:

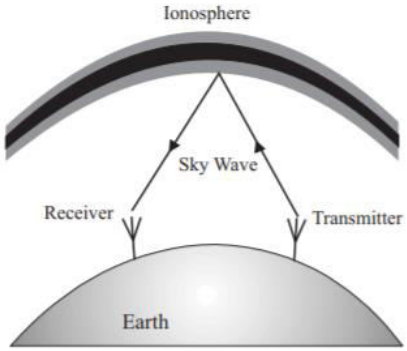
- **C layer** at about 60km above the surface of earth reflects e.m. waves in the frequency range 3kHz – 300kHz. It is therefore used for direct long range communication.
- **D layer** at a height of about 80km reflects e.m. waves in the low frequency range (3kHz – 300kHz) but absorbs waves in the medium frequency range (300 kHz – 3MHz) and high frequency range (3 – 30MHz).
- **E layer** at height of about 110km helps in propagation of waves in the medium frequency range but reflects waves in the high frequency range in the day time.
- **F1 layer** at a height of about 180 km lets most of the high frequency waves to pass through.
- **F2 layer** (at a height of 300 km in daytime and 350 km at night) reflects e.m. waves upto 30MHz and allows waves of higher frequencies to pass through.

Ground Wave Propagation

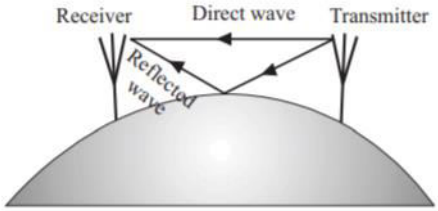
In ground wave propagation, the electromagnetic waves travel along the surface of the earth.

Sky Wave or Ionospheric Propagation

In sky wave or ionospheric propagation, the electromagnetic waves of frequencies between 3MHz – 30MHz launched by a transmitting antenna travel upwards, get reflected by the ionophere and return to distant locations. In this mode, the reflecting ability of the ionosphere controls the propagation characteristics of the sky wave.



Space Wave Propagation

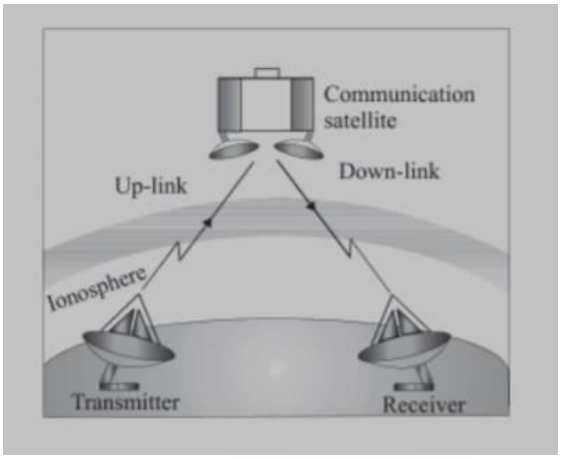


In space wave propagation, some of the VHF radio waves (30 MHz – 300MHz) radiated by an antenna can reach the receiver travelling either directly through space or after reflection by the curvature of the earth.

Satellite Communication

The modulated carrier waves are beamed by a transmitter directly towards the satellite.

The satellite receiver amplifies the received signal and retransmits it to earth at a different frequency to avoid interference. These stages are called uplinking and down-linking.



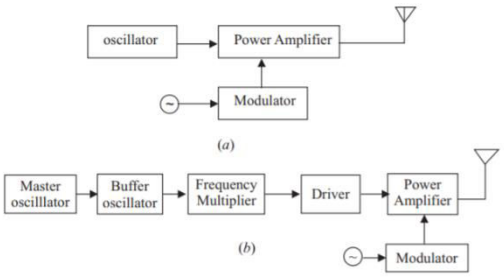
MODULATION – ANALOGUE AM AND FM, DIGITAL (PCM)

The process of processing a signal to make it suitable for transmission is called modulation

- **Amplitude modulation,**

  The amplitude of a high-frequency carrier wave is modified in accordance with the strength of a low-frequency audio or video modulating signal . When the amplitude of the modulating wave increases, the amplitude of the modulated carrier also increases and vice versa — the envelope of the modulated wave takes the form depending on the amplitude and frequency of modulating signal

$$\upsilon_c^{mod} = \upsilon_{co}(1 + m_a \sin\omega_a t)\sin\omega_c t$$
$$= \upsilon_{co}\sin\omega_c t + \upsilon_{co} ma \sin\omega_a t \sin\omega_c t$$
$$= \upsilon_{co}\sin\omega_c t + \frac{\upsilon_{co} m_a}{2}\cos(\omega_c - \omega_a)t - \frac{\upsilon_{co} m_a}{2}\cos(\omega_c + \omega_a)t$$



- **frequency modulation**

  The amplitude of the carrier wave remains constant, but its frequency is continuously varied in accordance with the instantaneous amplitude of the audio or video signal. When the amplitude of the modulating signal voltage is large, the carrier frequency goes up, and when the amplitude of the modulating signal is low, the carrier frequency goes down, i.e., the frequency of the FM wave will vary from a minimum to a maximum, corresponding to the minimum and maximum values of the modulating signal

- **Phase modulation**

  It involves changing the phase angle of the carrier signal in accordance with the modulating frequency. Analog pulse modulation is either amplitude modulated or time modulated. Similarly, digital pulse modulation is of two types: pulse code modulation and pulse delta modulation.

Pulse code modulation

the modulating signal is first sampled, and the magnitude (with respect to a fixed reference) of each sample is quantised. (It is a digital representation of an analog signal where the magnitude of the signal is sampled regularly at uniform intervals of duration Ts . The binary code is transmitted usually by modulating an analog current in a transmission medium such as a landline whereas pulse code modulation is used in digital telephone systems and for digital audio recording on compact discs.

DEMODULATION

The modulated signal carrying the information, once radiated by the antenna, travels in space. Since there are so many transmitting stations, thousands of signals reach our antenna.

Check Yourself

1. In amplitude modulation, which among the following is constant?
   a) Amplitude
   b) Frequency
   c) Wave length
   d) Time period

2. Which of the following is constant in the case of frequency modulation?
   a) Modulation
   b) Wavelength
   c) Amplitude
   d) Frequency

3. Examples of analog modulation techniques
   a) Frequency type modulation
   b) Amplitude type modulation
   c) Both a and b
   d) None of the above
4. What is the function of demodulation?
   a) Modulates signal
   b) Demodulates signal
   c) Maintains signal
   d) None of the above
5. Bandwidth is expressed in terms of

   a) Bits per second
   b) Hertz
   c) Meter

d) Second

Stretch Yourself

1. Calculate the wavelength of a radio wave of frequency of 20 MHz propagating in space.
2. What is the frequency range of X-ray and infrared ray
3. The core of an optical fibre is made of glass with a refractive index of 1.51 and the cladding has a refractive index of 1.49. Calculate the critical angle for total internal reflection
4. What is demodulation?
5. Distinguish between the terms analogue and digital signals. Define a 'bit'

Hint to Check Yourself

1B 2C 3C 4B 5A