4. Explain in detail about Electromagnetic spectrum.

Wireless communication is based on the principles of broadcast and reception of electromagnetic waves. These waves can be characterized by their frequency (f) or their wavelength (λ). Frequency is the number of cycles (oscillations) per second of the wave and is measured in Hertz (Hz), in honor of Heinrich Hertz, the German physicist who discovered radio, and wavelength is the distance between two consecutive maxima or minima in the wave. The speed of propagation of these waves (c) varies from medium to medium, except in a vacuum where all electromagnetic waves travel at the same speed, the speed of light. The relation between the above parameters can be given as

$$C=\lambda*f$$

where c is the speed of light ($3 \times 108m/s$), f is the frequency of the wave in Hz, and λ is its wavelength in meters.

ITU, located in Geneva and a sub organization of the United Nations, coordinates wired and wireless telecommunication activities worldwide. There are no official names for the bands in which the very high-frequency X-rays and Gamma rays fall.

The low-frequency bands comprised of the radio, microwave, infrared, and visible light portions of the spectrum can be used for information transmission by modulating the amplitude, frequency, or the phase of the waves.

The high frequency waves such as X-rays and Gamma rays, though theoretically better for information propagation, are not used due to practical concerns such as the difficulty to generate and modulate these waves, and the harm they could cause to living things.

Radio waves are easy to generate and are widely used for both indoor and outdoor communication due to properties such as their ability to pass through buildings and ability to travel long distances. Since radio transmission is omni directional (when radio waves are generated, they spread out from the transmitting antenna in all

directions) in nature, the need to physically align the transmitter and receiver also does not arise.

The frequency of the radio wave determines many of the characteristics of the transmission.

At low frequencies the waves can pass through obstacles easily, but their power falls with an inverse-squared relation with respect to the distance. The higher frequency waves are more prone to absorption by rain drops, and they get reflected by obstacles.

In the VLF, LF, and MF bands the propagation of waves, also called as ground waves The maximum transmission ranges of these waves are of the order of a few hundred kilometers. They are used for low bandwidth transmissions such as amplitude modulated (AM) radio broadcasting

The HF and VHF band transmissions are absorbed by the atmosphere near the Earth's surface.

However, a portion of the radiation, called the sky wave, radiates outward and upward to the ionosphere in the upper atmosphere.

SNR is the ratio of the signal power to the noise power on a transmission medium, and is used to categorize the quality of a transmission. However, because of the higher frequency of operation they do not pass through buildings.

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Infrared waves and waves in the EHF band (also known as millimeter waves) are used for short-range communication.

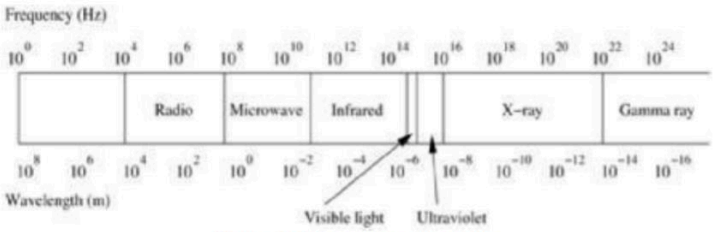

Figure 1.4 Frequency Spectrum

Spectrum Allocation

Worldwide, an agency of the International Telecommunications Union Radio communication (ITU-R) Bureau called World Administrative Radio Conference (WARC) tries to coordinate the spectrum allocation by the various national governments, so that communication devices that can work in multiple countries can be manufactured. Methods used for this frequency allocation are comparative bidding, lottery system and auctioning method.